Analysis of the South African Energy Policy Key Drivers

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LIST OF ABBREVIATIONS USED

CCGT	Combined Cycle Gas Turbine
CERs	Certified Emission Reductions
CO2	Carbon Dioxide
CSP	Concentrating Solar Power
DME	Department of Minerals and Energy
DNI	Direct normal irradiation
DoE	Department of Energy
DMR	Department of Mineral Resources
DSM	Demand Side Management
DTI	Department of Trade and Industry
DWAF	Department of Water Affairs
EEDSM	Energy Efficiency Demand Side Management
EIA	Environmental Impact Assessments
CFB	Circulating Fluidised Bed
FGD	Flue Gas Desulphurisation
GDP	Gross Domestic Product
GHG	Greenhouse gases
GJ	Gigajoule
GW	Gigawatt
GWh	Gigawatt hours
IEA	International Energy Agency
IPAP	Industry Policy Action Plan
IPPs	Independent Power Producers
IRP	Integrated Resource Plan
LNG	Liquefied Natural Gas
LOLP	Loss of load probability
LTMS	Long-term mitigation scenarios
MTPPP	Medium Term Power Purchase Programme
MW	Megawatt
MYPD	Multi-Year Price Determination
NERSA	National Energy Regulator of South Africa;
NOx	Nitrogen Oxide

OCGT	Open Cycle Gas Turbine
PPA	Power purchase agreement
PV	Photovoltaic
REFIT	Renewable energy feed-in tariff
SWH	Solar water heaters
TJ	Tera joule
TWh	Tera Watt hours
WASA	Wind Atlas for South Africa

ABSTRACT

The energy landscape is experiencing major changes globally. These changes are influenced and driven by various factors such as climate change, economic drivers, development and sustainability of base load energy demand. This has placed the onus on governments to optimally manage available energy resources.

Have changes in the global energy landscape altered the South African energy objectives, and have they influenced the factors that drive the country's Energy Policy? This research study analyses how the South African energy policy has developed over time and highlights the key drivers to date.

The findings of research study indicates that the key drivers of South African Energy policy are reduction in greenhouse gas emissions, economic growth and realising social development objectives. Policy makers continue to face critical choices in meeting the energy demand, optimising energy resources, managing greenhouse gas emissions and realising set economic objectives pursuant to formulating a policy that caters for the country's requirements.

CHAPTER 1. INTRODUCTION TO THE RESEARCH

1.1 Introduction

In South Africa, energy policy has been an important feature of the public dialogue in recent years. There have been debates and varying views around climate change, the growing power generation capacity deficit, and the development of various energy technologies to cater for the country's energy demand.

As demand continues to exceed available supply and reserve margins decrease, South Africa continue to face the challenge of catering for energy demand. The South African government is exploring ways to meet the country's energy requirements sustainably. How it addresses the country's energy requirements hinges on the direction of its energy policy.

1.2 Research Questions

The direction of South African energy policy has evolved over time from an energy sector dominated by fossil fuel to the planned balanced power mix that promotes the inclusion of renewable energy sources.

What are the key drivers of the energy policy that have led to the transformation of South Africa's energy sector?

Have the following factors influenced the energy policy?

- Energy resource availability
- Economic growth
- Climate change
- Social development
- Energy import and export options

1.3 Research Approach

The research was conducted and concluded using a three step approach as outlined in Figure 1.1. The process entailed research design, literature survey and analysis, and was concluded by reporting on the findings.

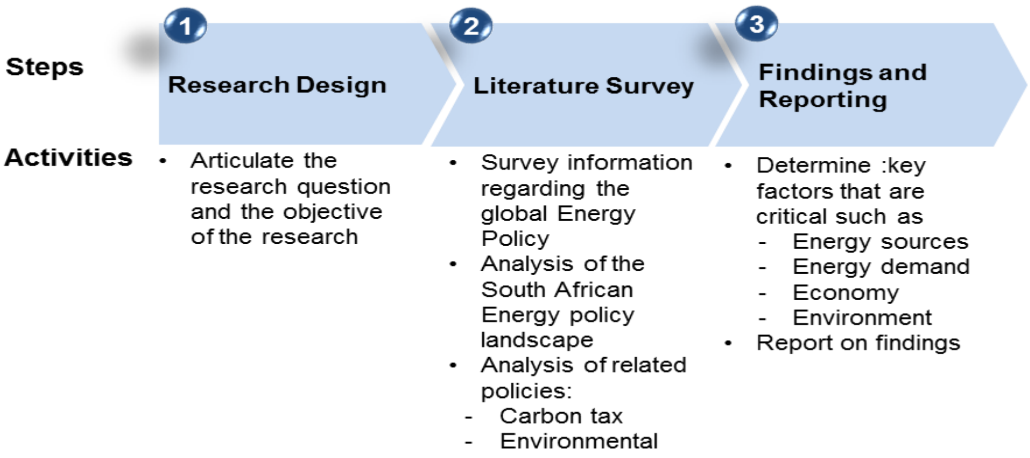


Figure 1.1: Research approach

1.4 Literature Survey

This research study seeks to understand and identify the key drivers of the South African energy policy. To achieve this, related literature was reviewed both in the South African context and globally.

The literature review included an analysis of the South African energy policy and other related government policies. Information between policies was then correlated to determine convergence and similarities. The Integrated Resource Planning 2010 document was also analysed to determine the current policy direction from the strategic planning perspective.

Further literature survey was conducted to determine energy policy trends globally. Energy policies of selected countries were reviewed to determine global policy direction. The global trends were then assessed to determine how they have influenced South African energy policy and to determine whether they are also key drivers.

1.5 Findings and Reporting

The third and final step was the analysis of the findings through collating the data from the surveyed literature to answer the posed research questions. The findings are presented in this research document

1.6 Significance of the Study

South Africa, as observed in the Integrated Resource Plan 2010 (IRP 2010), has embarked on a noble yet challenging mission of transforming the energy mix as it plans to develop an additional renewable energy and nuclear power capacity of 37 GW by year 2030.

This research study assesses and seeks to understand current South African energy policy and consequently determine its key drivers and how these drivers are likely to shape the South African power mix in the future

1.7 Delimitations of the Study

The study assesses the energy policy key drivers starting from the development of the 1998 White Paper on energy. Energy policy developments prior to 1998 were not assessed.

Due to the relatively small size of oil and gas in South Africa, the focus is primarily on the energy sector as it relates to power generation for the production of electricity.

Energy resources that are researched are mainly coal, gas, hydro, nuclear, wind, concentrated solar power, and photovoltaic of installed plant capacity of 50MW and larger. The study does not assess nor compare the various technologies and energy resources.

CHAPTER 2. LITERATURE REVIEW ON ENERGY POLICY

2.1 Introduction

A government policy comprises general principles that guide a government or legislature in the management of public affairs, with key objectives for the welfare and prosperity of the state and its people [3]. Government policies represent a point of departure for planning and ultimately determine the course of action for implementation.

Governments use policies to manage a wide range of state affairs from education, immigration, land rights, energy, etc. Policies are developed by government departments and during development may be influenced in various ways by stakeholders such as political parties, civil groups, community groups, business community, and non-governmental organisations.

Energy resources are crucial assets and major contributors to many countries' Gross Domestic Product (GDP) growth, consequently they are important resources that must be well managed by any country.

Management of energy resources is normally outlined in the country's energy policy. This guiding document outlines how a country plans to manage its energy resources to ensure that they are secured and sustainable for the beneficial use of its people [3]. Most governments place the management of energy resources and the development of the policy under the auspices of an organisation like South Africa's Department of Energy

Key features of an energy policy include guidelines on energy production, energy conservation, regulation, legislation, import and export of energy, international treaties, incentives to investment, emissions guidelines, taxation, and other related government policies that will impact on the availability and sustainability of energy resources.

The crucial first step towards the effective management of energy resources is the development of energy policy. As shown in Figure 2.1, the next step after the energy policy is developed is to formulate the energy strategic plan. This plan is based on the direction set out in the policy and outlines how the policy will be realised.

Once the strategic plan is finalised, an execution plan is developed detailing how the government and other energy stakeholders will interface to implement the developed plan.

Policy implementation is the final step of the process entailing the construction of the physical energy infrastructure. Implementation requires the government to have acquired resources which include the ability to finance, skills and capacity. Due to external market influences, the strategic plan often requires adjustment during implementation. Implementation includes government departments, state-owned institutions and the private sector.

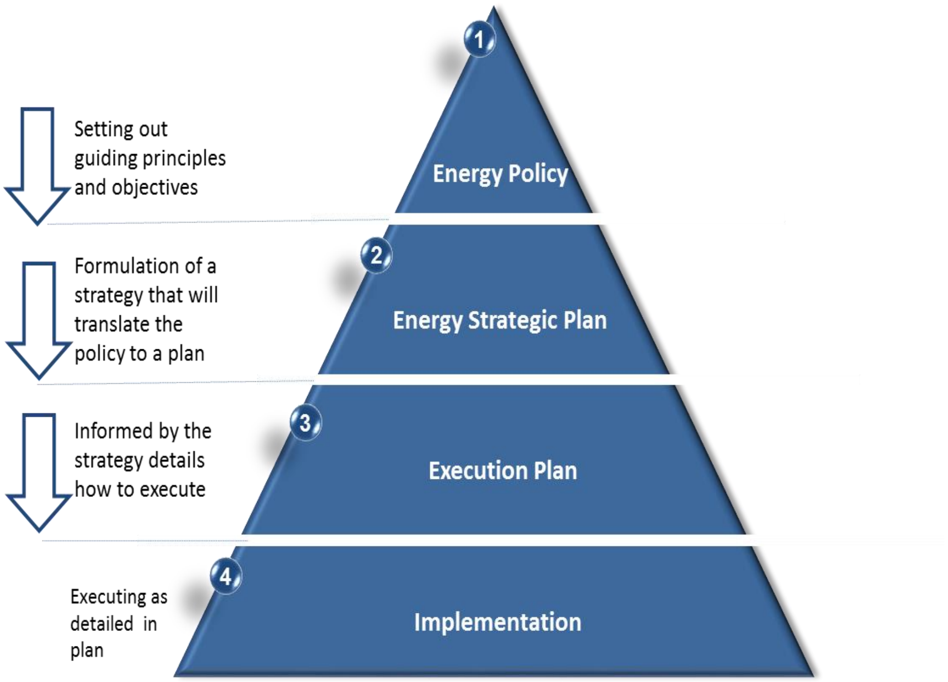


Figure 2.1: Energy policy development and implementation steps

2.2 Development of an Energy Policy

The energy policy is often the responsibility of governments with the designated department (usually a Ministry of Energy) leading the development. Government's overarching responsibility is to ensure that policies are integrated and work collectively towards the advancement of common country objectives

2.2.1 Process of Formulating the Energy Policy

The process of developing an energy policy differs from one country to another, as does the level of consultation with the public and stakeholders. The process is government led; outside stakeholders are included to supplement the overall team.

The mapped process as depicted in Figure 2.2 outlines five key steps followed by most governments in formulating the energy policy. The responsibility of managing state resources rests with the designated government department mandated for this task.

	1	2	3	4	5
Key Tasks	Set Energy Policy Objectives	Selection of a Team within the Sector	Key Energy Factors Analysis	Balancing Key Factors and Set of Objectives	Documentation of the Energy Policy
Activities	• Set key goals that the policy will be addressing. Objectives may include: - Energy supply management - Economic development - Environmental management	• Select expert across the sector to be as inclusive as possible • Experts could be from these institutions: - Energy regulator - Universities - Power utilities - IPPs - Consulting firms	• Determine :key factors that are critical such as - Energy sources - Energy demand - Economy - Environment • Design and construct technical and economic model	• Strike a balance to reach set objectives in alignment to key factors	• Document guiding principles on energy set objectives and how these will be realised • Release document for public discussion and inputs
Objectives	• Align with overall country objective and give direction on what the policy seeks to achieve	• To have wide variety of experts to give inputs and objectively	• Objectively determine how each of the factors will impact on set objectives and how to mitigate against adverse outcomes	• Ensure that identified factors are managed and there are mitigation mechanism to harmonise key objectives	• Final deliverables including objectives, how to reach them timeframes for implementation in a form of policy document

Figure 2.2: Energy policy formulation process

2.2.2 Energy Policy Objectives

The first and most critical step is setting out policy objectives. Energy policy direction influences other sectors, including energy-intensive industries. Therefore there has to be consistency and alignment of objectives with other related departments that will be affected by the policy. This takes place primarily through integrating overall government objectives and in related industries such as transport, environment and minerals.

Although guiding principles may be identical in the development of the policy, the objectives may vary vastly depending on challenges and resources specific to the country. Consequently, energy policy objectives take into consideration internal country interests' as well external factors related to the global influence of the country's energy sector, such as the following:

- Securing and sustaining energy resources.
- Economic development.
- Managing the environment.
- Increasing electricity access.
- Managing energy demand.

Energy objectives have to be linked to other objectives of the country, economic development being a case in point. Accessibility and affordability of electricity has a direct influence on the level of industrialisation. A country's inability to cater for the energy demand will adversely affect foreign investment in energy-intensive industries, as is also the case when the cost of electricity is relatively high and often unaffordable.

Securing and sustaining energy resources relates to how available resources can be developed to useful beneficiation of the people. This entails accurately assessing present and future available energy resources and understanding the demand in order to determine reserves. Government must then develop alternatives in the event of a deficit of resources in relation to supply.

2.2.3 Energy Policy Development Team

2.2.3.1 Government departments

As part of its oversight responsibilities, the government department responsible for energy could have additional portfolios, such as minerals and water. The core team is drawn mainly from within the designated ministry. However, depending on capacity and expertise levels, external energy experts and practitioners' services may be procured to augment the core team. The inclusion of both government and external experts creates a diverse team and engenders consideration of a variety of perspectives. Related government departments whose inputs are critical to the energy policy include those that will be directly or indirectly impacted. The departments of water, environment, minerals, and mining usually have vested interests in the development of the energy policy.

The reduction in greenhouse gas (GHG) emissions is a prime focus area in the energy sector with regard to environmental impact. Any ministry of environment will have a vested interest in how this is addressed [2]. The same applies to a department of water if it does not reside within the same ministry. This department would be interested in how energy policy addresses water conservation, especially technologies that require excessive use of water such as coal-fired power plants.

The reduction in greenhouse gas (GHG) emissions is a prime focus area in the energy sector with regard to environmental impact. The Ministry of Environment will have vested interest in how this is addressed in the energy policy [2]. The same applies to the Department of Water if it does not reside within the same ministry.

2.2.3.2 Energy regulator

The energy regulator plays an important role in the energy sector to ensure that the energy policy objectives are realised within the confines of compliance to regulation. The regulator is an independent body ensuring oversight and compliance of various stakeholders including utilities, independent power producers, and distributors of electricity.

2.2.4 Key Energy Factors Analysis

Factors that drive the energy policy are primarily concerned with catering for energy demand in a manner that allows for safe, sustainable management of available energy resources.

This implies that an ad hoc approach to energy demand management is inadequate as various factors have to be taken into account, including:

- Energy resources availability.
- Present and future management of energy resources.
- Development of power generation, transmission and distribution of electricity.
- Import and export of electricity.
- Present and future cost of electricity.
- Energy impact on the environment.
- Energy accessibility.
- Economic impact of energy.
- Impact of energy on national security and safety.

These key factors can be illustrated as inputs to policy which enables appropriate plans to be developed leading to implementation as shown in Figure 2.3.

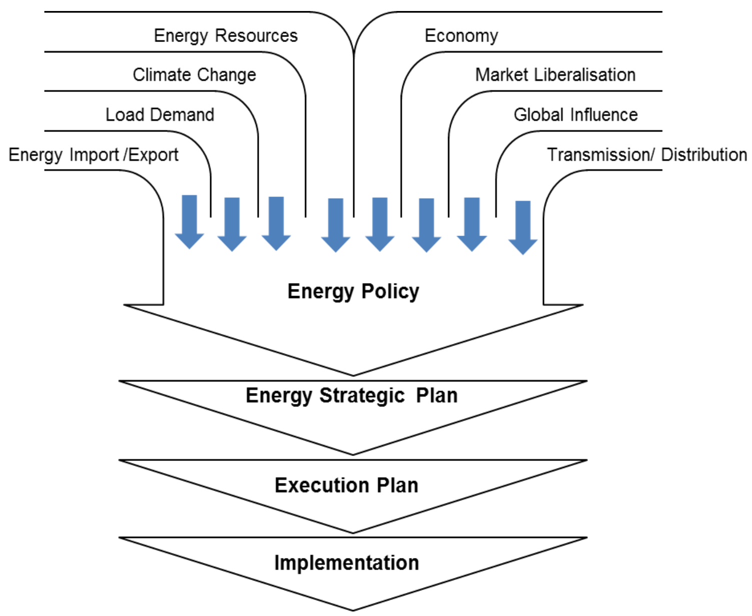


Figure 2.3: Key factors in the energy policy

2.2.4.1 Energy resources

Energy resources are not infinitely available, necessitating stringent management of present resources and the continued exploration of future options. Therefore available resources reserves have to be quantified in terms of the future projections and in relation to the current rate of consumption.

These factors have to be aligned and their potential impact on set objectives assessed. Available resources such as coal harm the environment and strain or limit energy resource options available for consideration. Renewable energy sources such as wind may be inadequate to cater for base load demand and may be relatively expensive, which would impact on the cost of electricity and, consequently, the national economy [8]. Inability of available energy resources to cater for a country’s demand may result in an energy crisis.

2.2.4.2 Environment

Energy is one of the leading greenhouse gas (GHG) emitters. Consequently, the management of the environment has become a prominent energy policy issue. Efforts to reduce greenhouse gas emissions have influenced the development of energy resources that are less harmful to the environment [3] [10].

Several mechanisms, such as a carbon tax, have been mooted to curb the production of energy from sources that emit GHGs, such as coal [9]. Globally, there is a drive to equip existing and new coal power plants with emission reduction devices such as carbon capture and storage, and flue gas desulphurisation (FGD). The development of renewable energy sources (RES) has also been incentivised through various programmes and schemes, including, in South Africa, the Renewable Energy Feed-In Tariff (REFIT) [4] [10]. This has since been replaced with a competitive bidding scheme.

2.2.4.3 Energy import and export

Countries have varying levels of energy resources. Through integrated electrical transmission networks, power can be imported or exported between countries. Countries like France export power to several neighbouring countries and South Africa has been a net exporter of power in Southern Africa [10].

In the Southern African region, the Southern African Power Pool was formed with the objective of integrating the regional electrical transmission networks. As a collective the region had surplus of installed generation capacity, mainly supplied from South Africa. This implied that there was no need for other countries like Botswana, Swaziland and Mozambique to build additional power generation capacity.

Therefore part of resource management includes options to procure energy resources from those countries that have a surplus. However regional integration is imperative in order to be able to optimise energy imports and exports.

2.2.4.4 Power transmission and distribution

Power generated from available resources has to be transmitted then distributed to the end user via an electrical grid. This comprises the transmission network, which transmits electricity from generation power plants via a high voltage electrical network normally ranging from 132kV to 1000kV. The transmitted power is then stepped down to a distribution level for consumption by the end user. Distribution levels also differ per power utility and the voltage can range from 44kV to 11kV at the medium voltage level and 400V line voltage and 230V phase voltage at the lower voltage level.

Advanced economies around the globe have been made possible through robust, secured, and accessible modern energy infrastructure. Grid capacity and availability is crucial to afford access to electricity for lighting and heating, and enable the provision of essential services such as health care, education, and water which translates into better quality of life for all [10].

2.2.4.5 Energy sector liberalisation

Traditionally, many electricity industries are developed and operated within strictly regulated frameworks through state organs. Regulated frameworks are those in which most or all activities from generation, transmission to distribution of power are handled within vertically integrated state-owned utilities [12].

Liberalisation also known as Deregulation of the energy sector refers to the process of allowing private-sector companies to produce and sell energy [12]. The degree of liberalisation varies from wholly state-owned to a hybrid of Independent Power Producers (IPPs) and state-owned utilities, and to the extreme, fully liberalised privately owned IPPs [12].

The first serious attempt to form a liberalised electricity market was launched by Chile in 1982. England and Wales pioneered the way with the first market launch in 1990 [12]. Today, there are several countries that have had successfully operating IPPs for a number of years.

Several factors have driven the liberalisation of the market and encouraged other countries to follow in the same direction and these include:

- Inefficiencies in vertically integrated state owned utilities.
- Disproportionate focus on power supply.
- Power generation capacity mismatch.
- Growing construction cost of new power plants
- Poor DSM initiatives.

Various countries have applied different steps to progress through the different phases of the liberalisation process. In some countries, a first natural step was to open opportunities for competition between IPPs and incumbent utilities [12].

Other countries introduced the concept of contestability in various steps by giving electricity consumers the freedom to choose their supplier in different steps over time, depending on their level of electricity consumption [12].

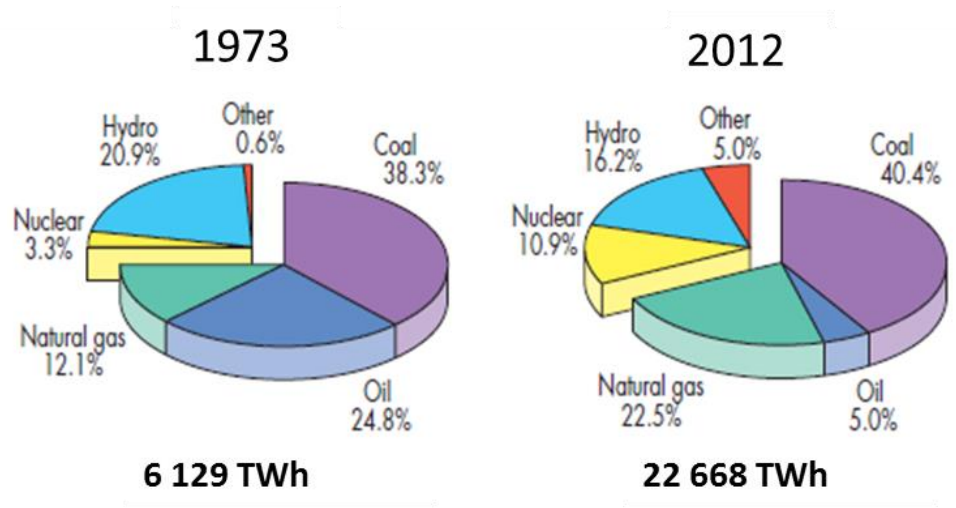
CHAPTER 3. ANALYSIS OF GLOBAL ENERGY POLICIES

3.1 Introduction

The global energy landscape is in constant flux due to changes in the global economy as well as advancements in energy technology. As the energy landscape continues to change, so do the energy policies of most countries. This is in response to, and keeping pace with, sustaining and securing energy resources while remaining consistent with international commitments [1].

Over time energy policies have shifted focus and objectives have adjusted in alignment with international best practice. These changes in energy policy have also impacted the power generation mix globally. While total generated power has increased in excess of 300% over the last four decades, as depicted in Figure 3.1, coal remains the leading source of power generation. As at 2012, coal accounts for 40.4% of world power generation capacity [1].

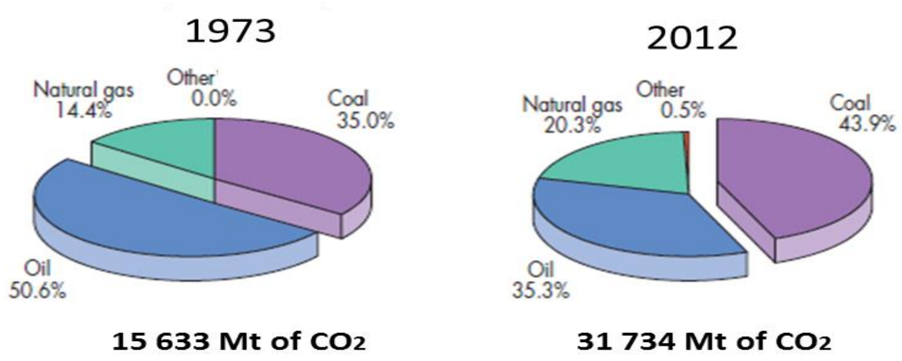
Nuclear has experienced the largest growth, from 3.3% to 10.9% [1]. Hydropower contribution declined from 20.9% to 16.2% between 1973 to 2012. However the sharpest decline is by oil, from 24.8% to 5%.



Source: Energy Information Administration, Annual Energy Outlook 2012 [1]

Figure 3.1: World electricity generation from 1971 to 2012

As depicted in Figure 3.2 below, fossil fuels account for more than 75% of carbon dioxide (CO_2) emissions. Emissions from oil have significantly declined from the initial CO_2 emission contribution of 50.6% to 35.3%. Coal contribution to CO_2 emissions has increased moving from 38.3% to 40.4% [1].



Source: Energy Information Administration, Annual Energy Outlook 2012 [1]

Figure 3.2: World electricity CO2 emissions from 1973 to 2012

Further analysis indicates that the United States and China jointly account for 59% of power generated from coal resources. China alone accounts for 41% of world power generated from coal, as analysed in Table 3.1 [1].

Table 3.1: Coal power generation

Country	Power Generation from Coal (TWh)	% Consumption
China	3 785	41%
United States	1 643	18%
India	801	9%
Japan	303	3%
Germany	287	3%
Korea	239	3%
South Africa	239	3%
Australia	171	2%
Russia	169	2%
United Kingdom	144	2%
Rest of the world	1387	15%

Source: Energy Information Administration, Annual Energy Outlook 2012 [1]

Regional CO2 emission analysis indicates a correlation between fuel sources used for power generation, as reflected in Table 3.1. Chinese emission levels have increased substantially from 5.8% to 26% during this period. OECD (Organisation of Economic Co-operation and Development) countries' emissions have plateaued, despite an increase in power-generation capacity. This translates into an overall decline from 66.1% contribution to 38.3% between 1973 and 2012 [1].

The main concern of climate change is global warming, which is based on the 'greenhouse' effect. Water vapour, carbon dioxide (CO_2), methane CH_4, nitrous oxide (N_2O), and ozone (O_3) are referred to as greenhouse gases [5]. Despite an increase in power generation from fossil fuels, OECD countries have demonstrated reductions in CO_2 emissions (a key objective of many countries' policies) by employing measures such as energy efficiency and the promotion of renewable energy sources [5].

The International Energy Agency, which has 28 member countries, has highlighted milestone changes in the energy policies in the following areas:

- General energy policy.
- Energy efficiency.
- Renewables.
- Oil and gas.
- Research and development.

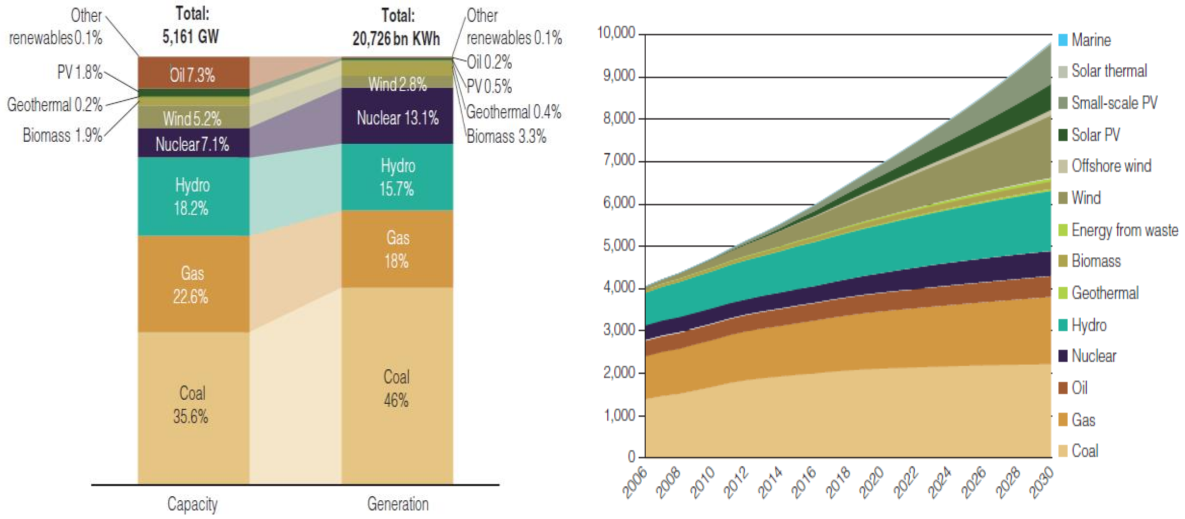
Major energy policy changes have been at the forefront in setting out emission reduction initiatives. Analysed trends show changes in how the power sector has evolved in the last 10 years in both developed and developing countries.

3.2 Global General Policy Observations

Coal accounts for 36.6% of the world's installed capacity, and 46% of generated power, as shown in Figure 3.3. Electricity production from fossil fuels (coal, gas, and oil) makes up approximately 65% of global power generation [10]. However, in 2012, the net investment in renewable power capacity outpaced that of fossil fuel generation [10].

Based on higher investments in new renewable power capacity relative to traditional fossil fuels, the projected global energy mix, as depicted in the Figure 3.3, reflects a decline in coal.

The global share of generation output from renewable technologies is expected to rise from approximately 23% in 2010 to around 34% by 2030. Wind and solar are forecasted to continue dominating the renewables space. Wind (onshore and offshore) is projected to rise from 5% in 2012 to 17% of installed capacity by 2030.



Source: World Energy Council, World Energy Perspective 2013 [16]

Figure 3.3: Global nameplate installed electricity capacity versus net generation

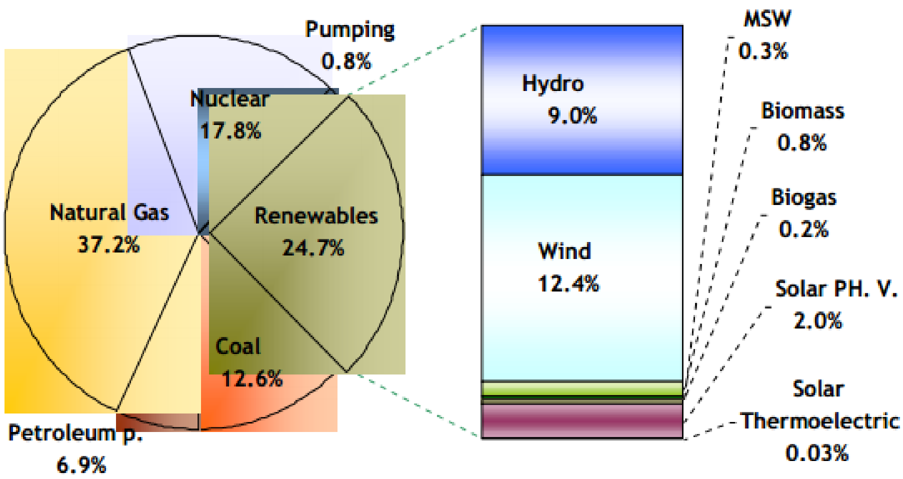
3.2.1 Analysis of Selected Countries' Energy Policies

Energy transformation is an approach that has been adopted by most countries and which has an impact at global level. Transformation is aimed at reducing the adverse impacts of climate change [1] [8]. Spain and Portugal are currently amongst countries that have demonstrated the type of radical energy transformation geared towards addressing climate change and reducing energy production from fossil fuels.

3.2.1.1 Spain Energy Sector Analysis

Spain is the fifth largest energy consumer in Europe and has an installed power generation capacity of 100 GW against the country's current peak demand of 44 GW. Strong government support for the development of renewable energy sources coupled with the sudden and severe economic crisis, has led to this situation of overcapacity [20].

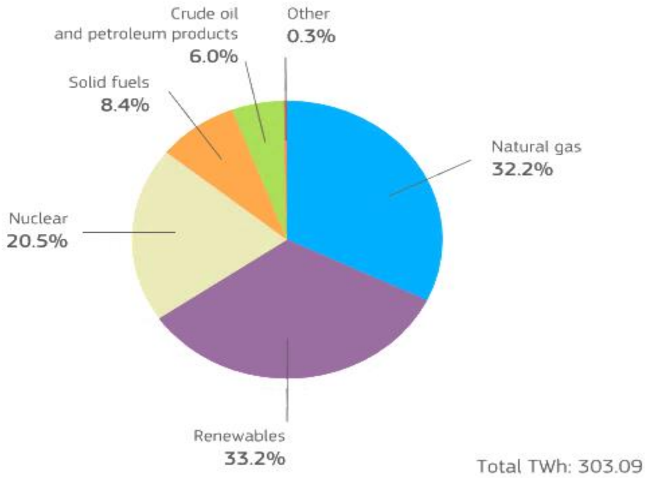
Spain's power mix is dominated by fossil fuel, mainly natural gas which contributes 37,2% and renewables account for 24,7%. Renewable Energy Sources are driven mainly by wind and hydro and respectively contribute12,4% and 9% [1].



Source: World Energy Council, World Energy Perspective 2013 [16]

Figure 3.4: Spain Energy Sources

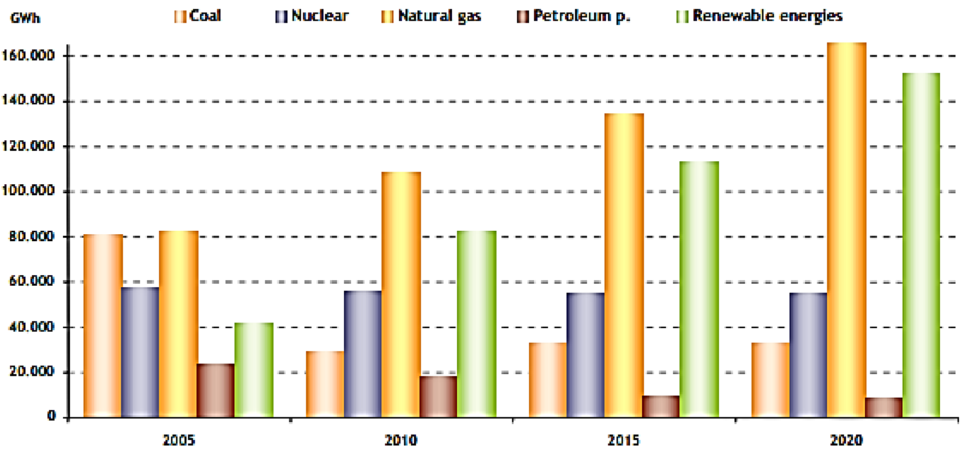
Spain has grown from just 2% wind and solar power to almost 20% in a period of ten years. Figure 3.5 demonstrates this growth at the same time as electricity consumption grew rapidly by 50% from 2000 to 2008 [20]. However, the global recession caused rapid price induced conservation since 2008. Spain now enjoys about 35% energy from renewable energy sources. This includes large hydroelectric, with the rest of Spain's energy coming from natural gas, coal and nuclear.



Source: World Energy Council, World Energy Perspective 2013 [16]

Figure 3.5: Spain energy mix Source: WEC, 2013

Spain remains on a positive trajectory that seeks to upscale the development of RES and continue to reduce the use coal as depicted in the Figure 3.6.

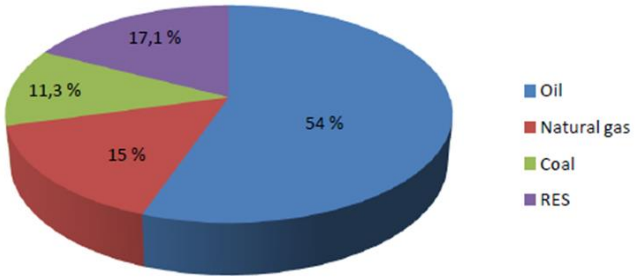


Source: World Energy Council, World Energy Perspective 2013 [16]

Figure 3.6: Spain forecasted energy mix

3.2.1.2 Portugal Energy Sector Analysis

Portugal's energy mix is highly dependent on imported oil and gas, which collectively account for 69% of the total energy consumption as depicted in Figure 3.7.

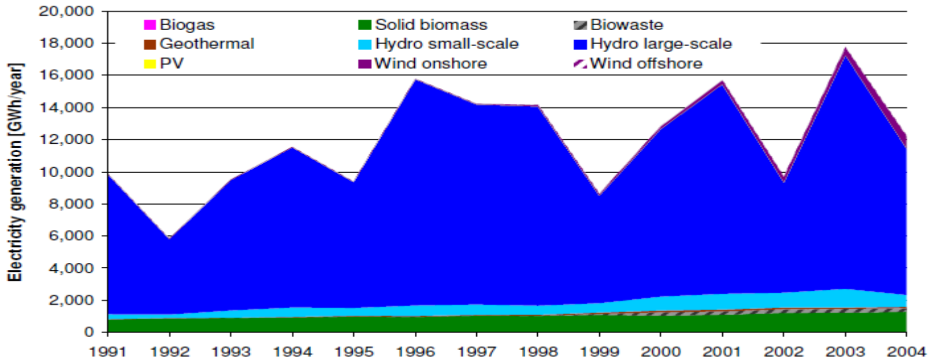


Source: Global Wind Energy Council 2011 [4]

Figure 3.7: Portugal energy consumption

In Portugal, the renewable energy power generation is dominated by hydro energy. In 2004, hydro contributed 9869 GWh (Gigawatt hours) out of a total green electricity production of 12 214 GWh. With a production of 1 264 GWh, solid biomass was ranked second highest as a renewable energy source in 2004. However, the overall trajectory indicates that there was minimal growth of renewables.

Although biogas, PV (photovoltaic) and onshore wind have low penetration levels they are experiencing considerable growth. Average annual growth rates of these technologies have been 47%, 62% and 54% respectively between 1997 and 2004. By 2005, the biogas sector had further doubled its production from 15 GWh in 2004 to 34 GWh in 2005. The onshore wind power sector doubled its capacity from 552 MW in 2004 to 1021 MW in 2005 [6].



Source: World Energy Council, World Energy Perspective 2013 [16]

Figure 3:8: Portugal renewable energy resources 2004

Portugal approved a new National Energy Strategy in 2005, replacing its 2003 strategy [3]. This new strategy redefined major political guidelines and relevant measures in the energy area. The following principal objectives were outlined in the National Energy Strategy:

- To guarantee security of energy supply, by diversifying primary resources and energy services and promoting energy efficiency.
- To stimulate and encourage competition, protecting consumers and promoting corporate competitiveness and efficiency.
- To guarantee the environmental adequacy of the energy process as a whole, reducing its environmental impacts on a local, regional and national level.

The major strategic guidelines established to achieve these three objectives included:

- The liberalisation of the electricity, gas and fuel markets.
- Creation of a competitive structural framework.
- Growth of renewable energy supply; promotion of energy efficiency.
- An efficient and environmentally sound public supply of energy.
- Reorganisation of the energy sector tax and incentive systems.
- Energy perspective, innovation and communication.
- Awareness and assessment of national energy strategy.

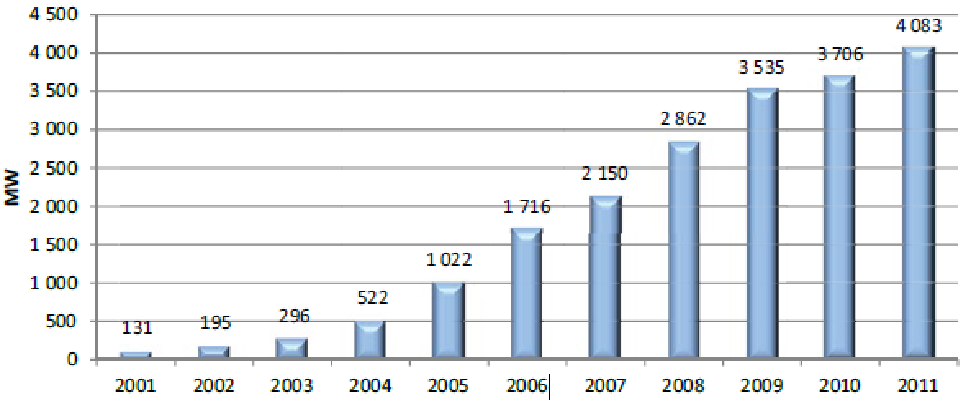
Portugal has demonstrated bold energy policy transformation over the years, as seen in the wind and solar energy growth from 2% in 2005 to over 15% by the end of 2009. Portugal implemented a stable feed-in tariff for renewable energy.

Guaranteed feed-in tariffs were applicable for electricity produced from cogeneration, renewable resources except for large-scale hydropower installations and endogenous resources. [3]. The Decree-Law 189/88 established the legal basis for the feed-in of electricity from independent power producers and grid operators are obliged to purchase any offered renewable electricity from IPPs [20].

The Renewable Energy Feed-in-Tariff (REFIT) assisted in accelerating Portugal's renewable energy programme. Portugal is now one of the leading countries in Europe in terms of wind power penetration of 17,6% of the total energy demand. The 2011electricity demand was met by over 4GW of wind power capacity as shown in Figure 3.9.

Wind energy is now the second most developed renewable source, after hydropower. Portugal adopted a target of achieving 20% of its energy consumption from renewables by 2020 under its National Renewable Energy Action Plan.

By 2020, Portugal intends to be generating 60% of its electricity from renewable resources, in order to satisfy 31% of its final energy consumption.



Source: World Energy Council, World Energy Perspective 2013 [16]

Figure 3.9: Portugal cumulative wind energy capacity

3.3 Spain and Portugal Observations

Spain and Portugal have succeeded in formulating energy policies that enabled transformation of their respective energy portfolios. Portugal has managed to substantially increasing their renewable energy power generation capacity. Spain has equally achieved in excess of 35 percent total renewables installed power generation capacity including large hydro power plants.

South Africa has also set radically emission reduction targets to be reached in 2030. Are approaches followed by Spain and Portugal in driving energy transformation through policy change applicable to South Africa?

CHAPTER 4. ANALYSIS OF THE SOUTH AFRICAN ENERGY POLICY

4.1 Introduction

The last energy policy White Paper before the advent of the democratic dispensation was published in 1986 [6]. The first energy policy White Paper under the democratic government was published by the Department of Minerals and Energy (DME) in December 1998

The development of the 1998 White Paper Energy Policy adopted a widely consultative process, emphasis was placed on transparency and the integration of the policy process. Prior to the finalisation and publication of the policy, the process began with wider consultation and transparency in 1994. The 1998 White Paper outline a set of objectives and the consultative allowed for inputs from various

stakeholders within the energy sector.

Once the Energy policy was finalised a strategic planning document referred to the IRP 2010 was developed.

The IRP 2010 Revised Balanced Scenario (IRP 2010 RBS) detailed how the energy policy direction as outlined in the 1998 Energy Policy White Paper would be realised. The IRP 2010 RBS was developed through wide consultative processes involving the public, and it indicated the following key considerations [2]:

- Reducing carbon emissions.
- New technology uncertainties such as costs, operability, lead time to build etc.
- Water usage.
- Localisation and job creation.
- Southern African regional development and integration.
- Security of supply.

4.2 Process of Energy Formulation

Based on transparency and inclusiveness, the process for the development of the South African energy policy drew on the greatest possibly variety of inputs. The process was begun in 1994 by a team of multi-disciplinary experts that delivered an Energy Discussion Document also referred to as the Green Paper [6].

The Energy Policy Discussion Document was followed by public consultation with the objective of gathering public views. This document was then released for public written comment in 1995 and a number of workshops were held to gather public written information [6].

In 1995, a team of individuals was selected on the basis of the level of their expertise to focus on specific energy issues. The contributions of these selected individuals were then edited by an editorial committee to produce a draft White Paper [6].

The approach adopted followed the following key steps

- Recognition of the problem
- Identification of underlying causes
- Identification of solutions
- Implementation of solutions
- Monitor and evaluate solutions effects

International influence has redefined the role governments as international multilateral lending agents continue funding the development of energy infrastructure. These international pressures and opportunities impact on South Africa's energy sector, and eventually, the local economy. Government has also recognised and factored the influence of the international world, into the formulation on the energy policy. In addition, as a member of the Southern African Development Community (SADC), South Africa had to take regional energy matters into account in formulating the policy.

4.3 South African Key Energy Stakeholders

The energy sector includes a number of stakeholders comprising governmental and non-government entities. These stakeholders have varying levels of influence on policy direction. The energy sector is then governed through the interaction of government, regulatory, and industry stakeholders, as depicted in Figure 4.1.

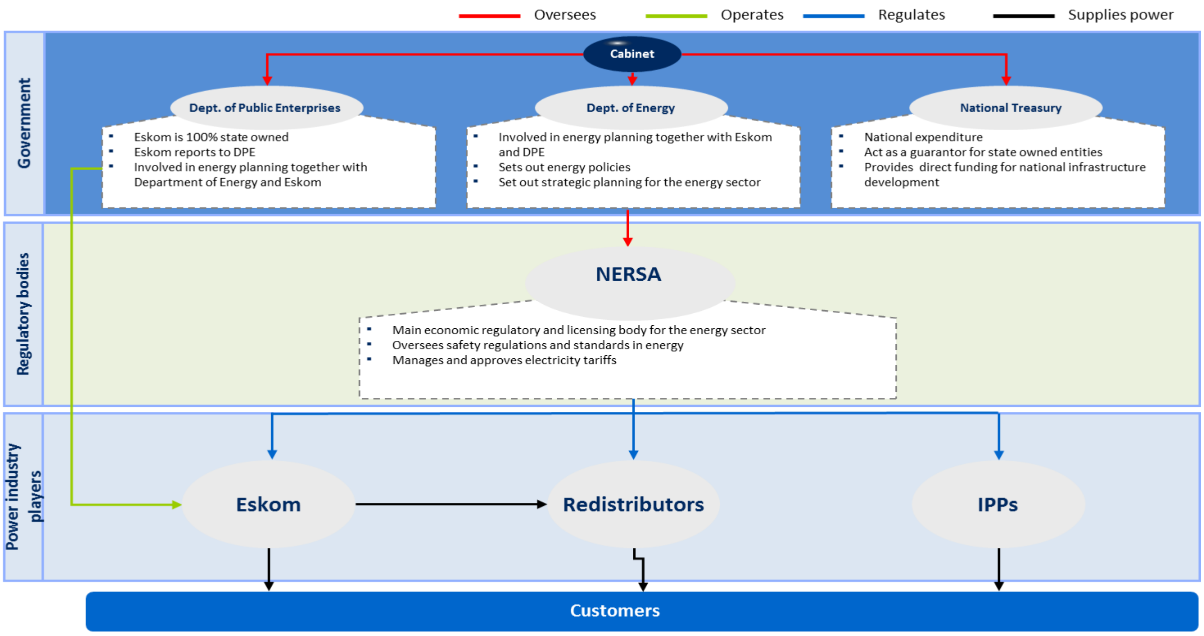


Figure 4.1: Energy stakeholders

Power industry players include the state-owned utility Eskom, which accounts for more than 90% of the country's power generation capacity. Most redistributors are municipalities that buy electricity from Eskom and resell to the end consumer. Presently most Independent Power Producers (IPPs) are in the renewable energy space. The process of energy policy development is overseen by the DoE in consultation with relevant stakeholders to ensure inclusivity.

Government oversight is mainly undertaken by the Department of Energy, Department of Public Enterprise (DPE), and the National Treasury. Energy sector regulation and licensing is the responsibility of the National Energy Regulator of South Africa (NERSA).

NERSA plays a critical role in supporting that government energy objectives are met. This is largely achieved through regulating the three key industries which are petroleum, electricity and piped-gas through a set of distinct regulatory functions. Electricity consists of four departments, piped-gas consists of two departments, and petroleum pipelines consist of two departments.

NERSA is a regulatory authority which has the following seven divisions:

- Electricity Regulation.
- Piped-gas regulation
- Petroleum Pipelines Regulation.
- Human Resources.
- Finance and Administration.
- Corporate Services.
- Special Support.

The energy industry in South Africa has significantly expanded in recent years. The industry is experiencing several particular challenges, including the introduction of IPPs, and security of supply.

NERSA performs an important role in supporting the Renewable Energy Independent Power Producers Programme (REIPPP). The primary role is oversight in facilitating the inclusion of private players in the energy market and also addressing the challenge of supply shortage by endorsing the right tariffs for IPPs to enable them to bring onto the grid the required power.

Challenges of climate change and emissions regulation have also put additional pressure on energy regulation. These challenges have upped the stakes on how the National Energy Regulator of South Africa (NERSA) creates customer value and develops its people while upholding the interest of South African society as a whole.

4.4 South African Energy Policy

Current South African energy policy stems from an Energy Policy Discussion Document, informally referred to as the Green Paper, initiated in 1995 to gather public views and inputs on the country's energy sector. The Energy Policy White Paper was finalised and released in 1998 taking into account written inputs from the discussion document.

Since the issuing of the White Paper on Energy Policy in 1986, South Africa has undergone various changes. The advent of a democratically elected government implied a new energy resource management vision inclusive of all South African citizens. The new democratically elected government formally launched the Energy Policy White Paper process in 1994 to replace the 1986 White Paper on energy policy

During the development of the 1998 Energy White Paper the following objectives were prioritised:

- Increasing access to affordable energy services.
- Improving energy governance.
- Stimulating economic development.
- Managing energy related environmental impacts.
- Securing supply through diversity.

The Integrated Resource Plan 2010 (IRP 2010), which is a strategic planning document outlining how objectives set out in the policy would be met, was developed and published in 2012.

The policy adopted by parliament in 1998 was implemented with varying degrees of success and many challenges, including delays in meeting national demand requirements resulting in supply deficit and, ultimately, loading shedding. Some of the successes include increased access to electricity to levels above 80%, making South Africa the leading country in sub-Saharan Africa in this regard.

4.5 South African Energy Resources

4.5.1 Overview of Energy Resources

South Africa power has historically been fossil fuel dominated with approximately 70% of the power generated through coal-fired power plants. This has been influenced largely by the availability of rich coal reserves, water scarcity, low natural gas and low oil reserves [5].

Energy is a key driver of South Africa's economy; consequently, energy intensity is used as a measure of gross domestic product (GDP). This is due to the country's economic structure, dominated by large-scale, energy-intensive primary mineral beneficiation plants and mining industries

Primary energy sources in South Africa are coal, crude oil, gas, hydro, nuclear, petroleum products, renewables and waste. Coal, as the major indigenous energy resource, is relied on for the generation of the country's electricity and a significant proportion of liquid fuels [14]. More than 90% of South Africa’s electricity is generated from the burning of coal. Based on rich coal reserves the energy sector developed to have the largest installed capacity in Africa and became a net exporter of electricity in Southern Africa.

South Africa has good solar and wind resources, although the deployment of renewable energy technologies has been slow to take off. Eskom, South Africa’s state-owned power utility has 27 operational power stations with 40.7 GW installed generation capacity. Additional power generation capacity is derived from hydro power imports resulting in a total capacity of about 43.5 GW supplying the country’s peak demand of approximately 36 GW.

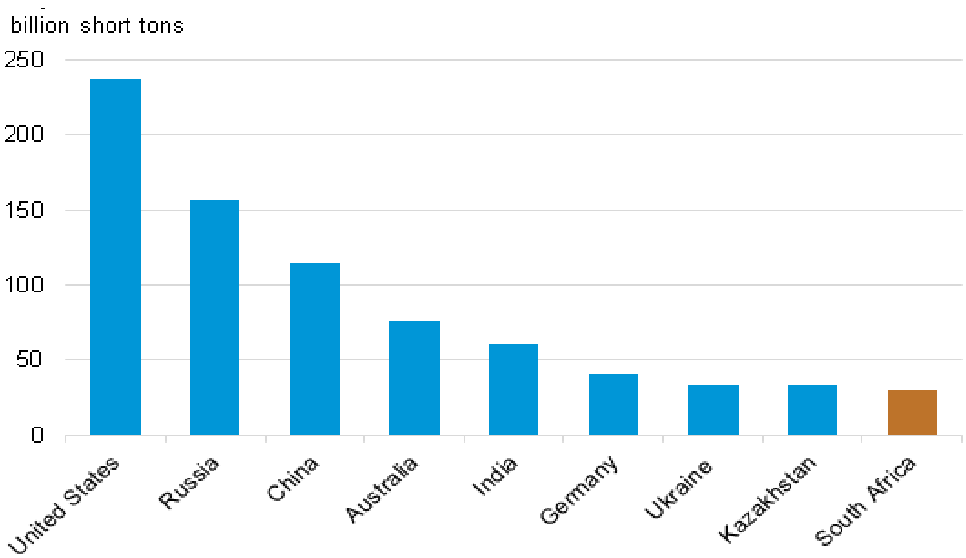
South Africa is a water-scarce country with limited hydro resources. Hydro power is imported from Mozambique from Cahora-Bassa hydro power station. Oil and gas resources are also limited energy resources, South Africa is a net importer of these resources. In 2009 renewable energy sources were recorded as the lowest energy supply due the slow pace of development [14].

4.5.2 Coal

Conventional energy sources based on coal, natural gas, and oil have been the main providers of base load energy globally and remain key economic drivers in many countries. This applies to South Africa with a power generation capacity dominated by fossil fuels [1]. In South Africa, more than 90% of power generation is from coal-fired power plants [2].

Coal plays an important role in the South African economy and is the primary energy source for power generation. It is also used for producing a substantial proportion of the country's liquid fuels. South Africa's coal reserves were estimated at 30.2 billion short tons by the end of 2012, accounting for 95% of total African coal reserves and approximately 4% of total world's reserves [6].

South Africa's coal mining is 47% underground mining and 53% opencast mining operations [14]. The coal mining industry is highly concentrated in large mines. Coal production feeds electricity generation, petrochemical industries, general industries, the metallurgical industry and merchants for local and export sales.

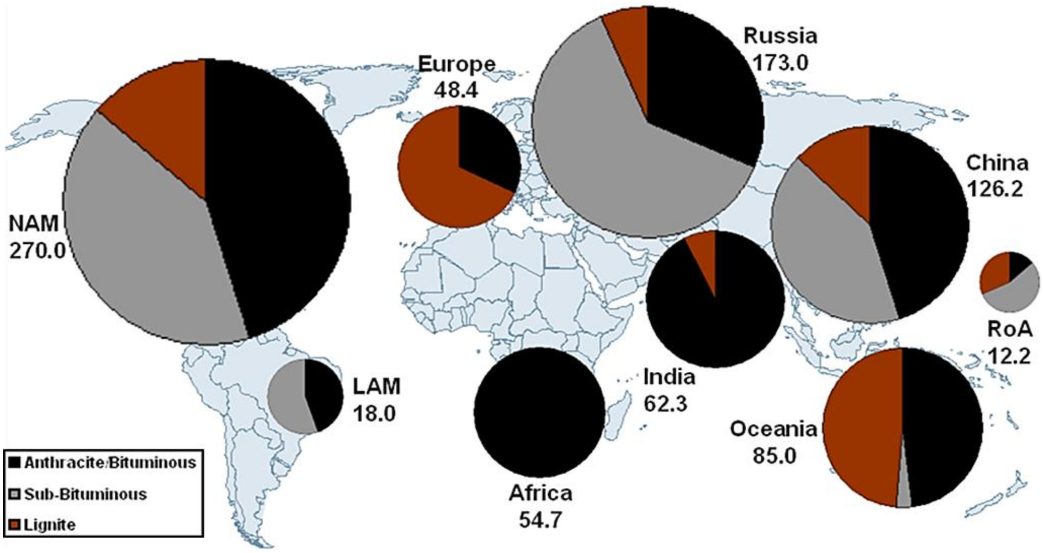


Source: International Energy Agency, Energy Policy Highlights 1974-2013

Figure 4.2: World coal producer ranking

Coal production increased from 220 million tons in 2002 to 253 million tons in 2011. This is a 14.7% increase in coal production (extraction) over 10 years. The total volume of coal sold increased by 8.6% over 10 years, from 227 million tons in 2002 to 247 million tons in 2011.

As observed in figure 4.3, South Africa's coal is bituminous anthracite, which has a relatively high calorific value.



Source: International Energy Agency, Energy Policy Highlights 1974-2013

Figure 4:3: World coal reserves by bituminous classification

In 2011, South African mines produced 252 756 845 tons of coal and 29% of produced coal was exported to Europe and China through the Richards Bay coal terminal, making South Africa the sixth largest coal exporting country in the world.

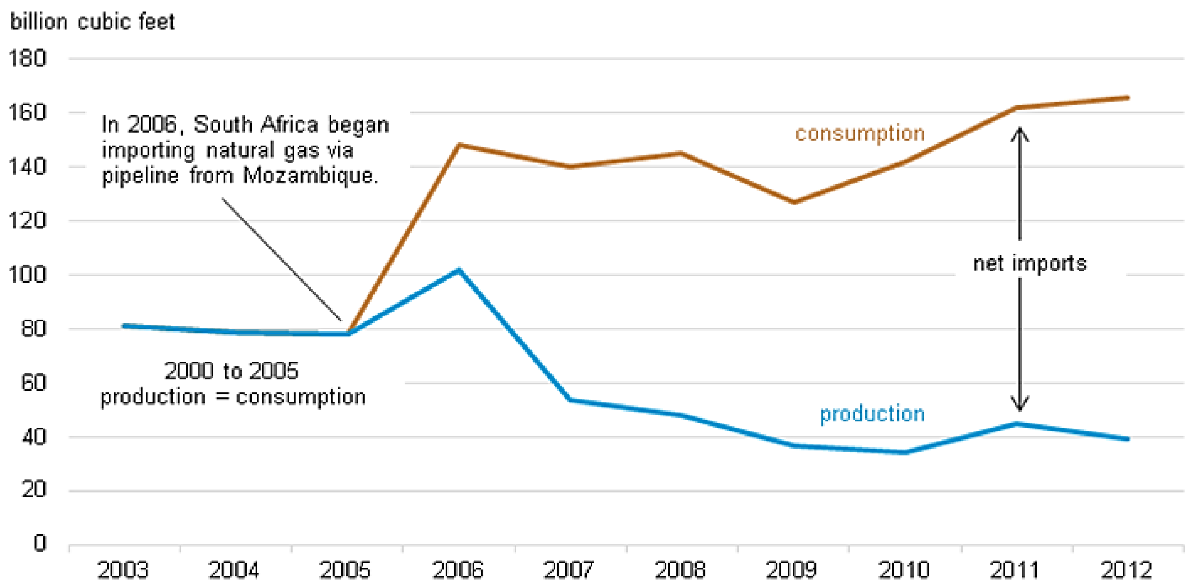
The estimated number of years to depletion for proven coal reserves, as at 2011, was 119 years. In 2002, there were 147 years left to depletion, decreasing to 119 years in 2011, which is a 19% decrease over the past 10 years [8]. Given current coal reserves, South Africa will continue to include coal in the power generation energy mix as a critical component to the base load capacity.

4.5.3 Oil and Gas

South Africa has very low natural gas reserves, currently there are no economically viable inland gas fields. In consequence of limited oil fields in the country, the bulk of crude oil is imported from the Middle East (Saudi Arabia, Iran, Kuwait, Yemen, Qatar and Iraq) and Africa (Nigeria, Egypt and Angola). Small oil and gas reserves are situated off the south coast of Mossel Bay [5].

Namibia and Mozambique have commercially viable gas reserves. With the latest results of ongoing exploration in Mozambique, prospects of more reserves are promising. The discovery of additional gas in Mozambique has resulted in an increase in imports into South Africa as observed in the Figure 4.4.

The Kudu gas fields are situated off the Namibian coast and have reserves of about 1.5 trillion cubic feet (tcf). Angola has two inland fields at Pande and Temane, with combined reserves of approximately 3 tcf. These present additional options for gas imports into South Africa.



Source: Energy Information Administration, Annual Energy Outlook 2012 [1]

Figure 4.4: South Africa natural gas consumption

4.5.3.1 Shale gas

Shale gas is hydrocarbon gas extracted from shale, as opposed to conventional reservoir rocks such as sandstone or limestone, or from other unconventional reservoir rocks, such as coal or tight (very low permeability) sandstone [15].

The composition of shale gas is not materially different from other forms of natural gas. It is primarily composed of methane (80% or more) mixed with varying amounts of other gases, including carbon dioxide (CO_2), oxygen (O_2), nitrogen (N_2), hydrogen sulphide (H_2S) and other hydrocarbons such as ethane (C_2H_6) and propane (C_3H_8) [6].

Shale gas resources are typically found between 1 500 and 4 000 metres beneath the surface and are exploited by wells with long horizontal sections in the shale beds. Shale gas production requires hydraulic fracturing ("fracking") to access the gas [15].

Fracking is a process that entails the drilling of wells to access the shale rocks. After the wells on a pad are drilled, cased and cemented, a device perforates the horizontal part of the production pipe to make small holes in the casing, exposing the wellbore to the shale [15]. Then a mixture of water (90%), sand (9.5%) and chemicals (0.5%) is pumped into the well under high pressure to create micro-fractures in the shale and free the natural gas or oil. Sand keeps the fractures open after the pressure is released. The chemicals are mainly agents to reduce friction and prevent corrosion. The water volumes per well are estimated between 7.5 and 15 million litres of water [15].

In the United State of America (USA), hydraulic fracturing has been used in the oil and natural gas industry since the 1940s, producing more than 600 tcf of natural gas and 7 billion barrels of oil. The USA has pioneered and improved hydraulic fracking and, used with modern horizontal drilling technology, fracking has unlocked vast shale reserves in the USA [15].

In South Africa shale gas was discovered in the Karoo basin of the Northern Cape. The Department of Mineral Resources (DMR) estimates that approximately 30 trillion cubic feet (tcf) shale gas can be produced [17].

However, in South Africa there have been uncertainties and government concerns with the development of shale gas primarily pivoting on fracking on the following issues:

- The need to use large volumes of carrier fluid (usually water).
- The potential pollution of water resources resulting from surface spills or underground leakage.
- The treatment and disposal of waste fluids.
- The potential ‘footprint’ of any development.
- Socio-economic impacts.

The use of large volumes of water, together with chemical additives raised concerns over the environmental and social implications of hydraulic fracking. South Africa is a water scarce country, and the Karoo region has very low annual rainfall and high evaporation, making it extremely dry. Some aquifers in the Karoo Basin are especially vulnerable to contamination [17].

Based on these concerns, the Department of Mineral Resources (DMR) issued a moratorium on exploration licences in February 2011 and convened a working group to study shale gas exploration in the Karoo within the South African context. The present study considers the impact of shale gas exploitation on land use, water use and air pollution. Commissioned by the Ministry of Minerals, this group put forward recommendations that should allow further exploration, with the exception of physical drilling. The moratorium was lifted in August 2012, making South Africa the first country ever to end a ban on fracking. Though several companies have technical cooperation permits, drilling is still prohibited in the Karoo.

Shale gas could be a game changer in the South Africa’s energy landscape and part of the answer to reducing dependency on coal as a base load energy source.

4.5.4 Uranium

South Africa is ranked among the top 20 countries in terms of uranium deposits, as detailed in the Table 4.1.

Table 4.1: Global uranium production, 2010 (Uranium Mining in Africa, Governance of Africa Resources Programme)

Country	Production (tu)	Percentage of total
Kazakhstan	17803	33
Canada	9783	18
Australia	5900	11
Namibia	4496	8
Niger	4198	7.8
Russia	3562	6
Uzbekistan	2400	4
United States	1660	3
Ukraine	850	1.5
China	827	1.5
Malawi	670	1.2
South Africa	583	1
India	400	0.7
Czech Republic	254	0.4
Brazil	148	0.2
Romania	77	0.1
Pakistan	45	0.08
France	7	0.01
Africa Total	9947	18
World Total	53663	100

Source: International Energy Agency, Africa Energy Outlook. 2013.

The implementation of the Nuclear Energy Policy of 2008 is a key mission of the Department of Energy. The policy provides a framework within which prospecting, mining, milling, and use of nuclear materials, as well as the development and utilisation of nuclear energy for peaceful purposes, takes place.

South Africa's existing nuclear power generation capacity is 1800MW produced from the Koeberg power plant built in 1984 in the Western Cape. Nuclear power accounts for approximately 6% of the country's installed capacity. The government, through Eskom, announced early in 2006 that it was considering building another conventional nuclear plant, possibly at Koeberg, to strengthen the network in the Western Cape.

Early in 2007, the Eskom board approved a plan to increase power generation capacity, including the construction of new nuclear power plant. The environmental impact assessment (EIA) process initiated in 2006 confirmed the selection of three possible sites for the next nuclear power units namely Thyspunt, Bantamsklip, and Duynefontein.

This new programme was planned to start with 4GW capacity utilising the pressurised water reactor (PWR) technology and the construction was planned to start in 2010, the first unit to be commissioned in 2016. The commercial process commenced in 2007, and Areva's EPR and Westinghouse AP1000 were short-listed bidders.

However, in December 2008, Eskom announced that it would not proceed with either of the bids from Areva or Westinghouse due to lack of finance, and the government confirmed delays of several years.

Subsequently, however, the government resuscitated the nuclear programme, which is now led by the Department of Energy (DoE) and the National Treasury. The procurement strategy has now included the signing of a memorandum of understanding with Russia. The new planned capacity as reflected in the IRP 2010 is now a total of 9,6GW.

Developments in nuclear power generation have been mainly driven by the plan to bring on additional capacity, which started in around 2006, as depicted in Figure 4.5.

South African national imperatives include localisation, advanced manufacturing capability, skills development, and job creation. The choice of a specific model also hinges on the following:

- The financial and strategic decisions as to structuring the power station assets.
- The extent of government support which will inform whether the structuring model will more closely resemble a Sovereign or Utility model.

The extent of a partner's financial involvement will inform whether the sovereign or utility financing model will be employed. As it stands, the construction of a nuclear fleet is currently an expensive option to be pursued solely by the South African government without involving the private sector.

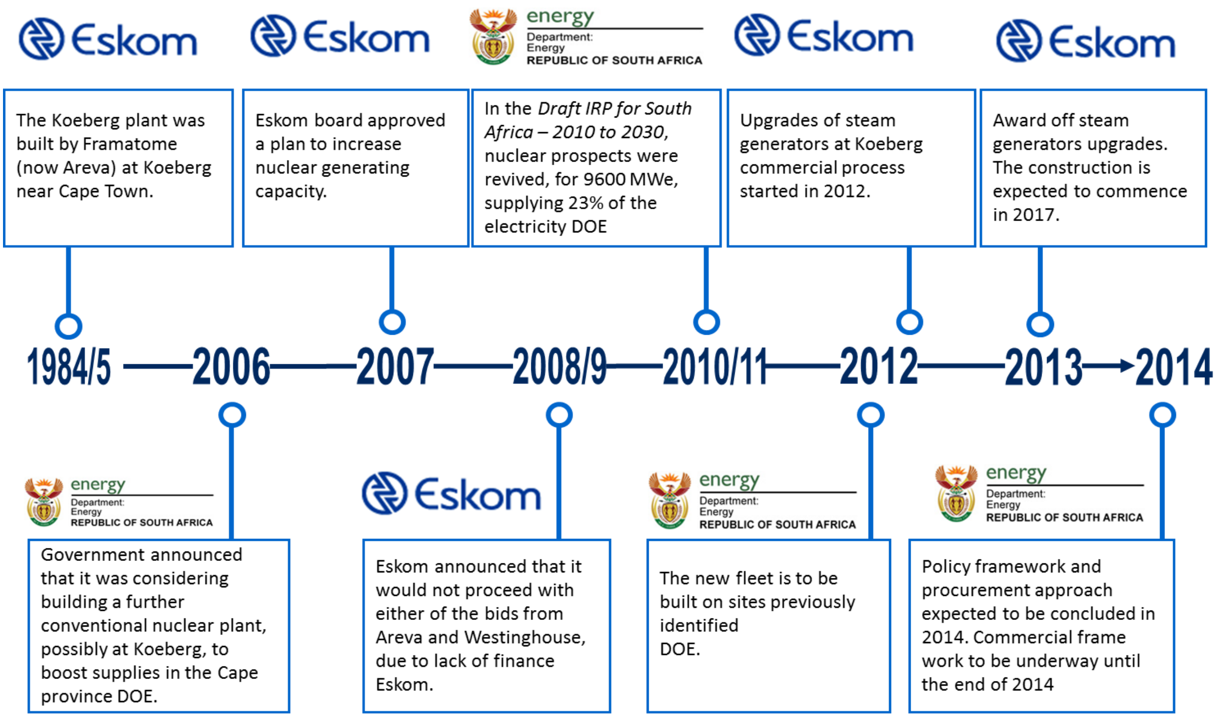


Figure 4.5: Timeline of nuclear programme development in South Africa up until 2014

4.5.5 Biomass

The harnessing of energy from biological mass is classified under renewable energy sources as it releases no additional carbon dioxide (CO_2) to the atmosphere because it absorbs the same amount of carbon in growing as it releases when consumed. The various types of biofuels are indicated in the following table 4.2.

Table 4:2: Types of biofuel sources

Woody Biomass Fuels	**Agricultural Residues**	**Waste Fuels**
Whole Tree Chips Tops & Limbs Forest Thinnings Sawdust & Bark Urban Wood Waste Railroad Ties Recycled Pallets Furniture Factory Wastes	Corn Stover Wheat Straw Rice Straw Rice Hulls Oat Hulls Rice Hulls Bagasse Orchard Prunings	Municipal Solid Waste Refuse Derived Fuel Tire-Derived Fuel Dried Sewage Sludge Paper Sludge and Waste Landfill Retrieved Solid Waste Landfill Gas Digester Gas
Energy Crops	**Manures and Agricultural**	**Biofuels and Biomass**
Switchgrass Hybrid Poplar Banagrass Arondo Donax Miscanthus	By-Products Cow Manure Chicken and Turkey Litter Hog Waste Wet Distiller's Grains Dry Distiller's Grains Lignin	Ethanol Biodiesel Crude Palm Oil White Pellets Torrefied Chips Black Pellets

The main sources of biomass in South Africa are fuel-wood found largely in the rural domestic sector, bagasse in the sugar industry, and pulp and paper waste in the commercial forestry industry for in-house heat and electricity generation. Much of South Africa's existing biomass involves inefficient household use based on questionably sustainable harvesting, primarily from natural woodlands (60%) although also from plantation off-take and woodlots [5].

One of the most attractive and easily implemented biomass energy technologies is co-firing with coal in existing coal-fired boilers. Co-firing refers to the process where biomass fuel and coal are combusted simultaneously in a boiler. In biomass co-firing, biomass can substitute for up to 20% of the coal used in the boiler. When it is used as a supplemental fuel in an existing coal boiler, biomass can provide the following benefits:

- Lower fuel costs.
- Reductions in sulphur oxide, nitrogen oxide.
- GHG emissions reduction.

According to the Department of Water Affairs and Forestry (DWAF), the key biomass resources that play a role in terms of renewable commercial plantations and the wood industry are woodlots, trees in the urban environment, woodlands and indigenous forests, and trees cultivated as fuel crops.

The National Biofuels Industrial Strategy initially focused on a short-term five-year pilot programme to achieve a 2% penetration of biofuels in the national liquid fuel supply, or 400 million litres per year - to be based on local agricultural and manufacturing production capacity [6]. The table below shows a summary of the South African biomass resources.

Table 4:3: Summary of energy potential from biomass in South Africa

Industry	Biomass	NCV (MJ/t)	Mass (1000t)	Energy Content	Power Potential (GWh/yr)
Sugar	Field Residue Bagasse	684 7117	5336 6136	10.21 12.12	2553 3031
Forestry	Softwood Hardwood	13016 11820	1588 1555	5.74 5.11	1650 1073
Saw Mill	Chips Dust Bark	10316 10611 10135	1433 730 443	4.11 2.15 1.25	1162 608 353
Pulp & Paper	Black liquor Sludge Bark	6243 5777 7975	5206 234 35	9.03 .038 0.76	2257 94 191
Total		**7958**	**23006**	**50.86**	**12972**

Source: Capacity Building Project in Energy Efficiency and Renewable Energy (CaBEERE) 2004

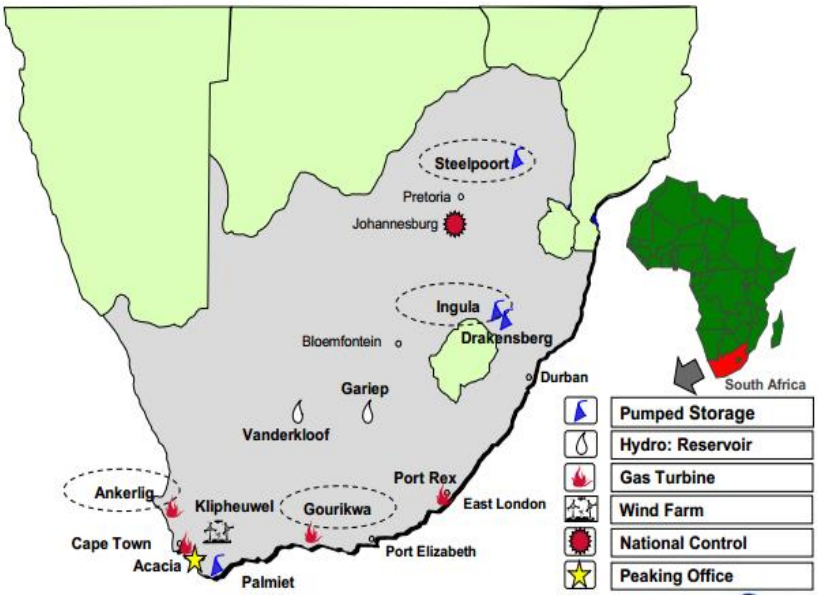
4.5.6 Hydro

South Africa has relatively few rivers that have sufficient capacity to produce large scale hydro power generation. The Orange (Gariep) River is the largest river in South Africa and it is 2100 km long with a catchment area of more than 1 million square kilometre (km^2). The Orange River rises in the Lesotho Highlands, flows through South Africa and drains into the South Atlantic Ocean.

Hydro power generation is mainly developed by Eskom, which has the following hydro power stations in the generation fleet, as depicted in Figure 4.6.

- Gariep – 360MW.
- Vanderkloof – 240MW.
- Drakensberg – 1000MW.
- Palmiet – 400MW.
- Ingula - 1332 MW expected to be completed in 2017

Gariep and Vanderkloof Power Stations, are located on the Orange River. Ingula pump storage is the most recent hydro scheme developed by Eskom that will have an installed capacity of 1332MW and is located in Kwa-Zulu Natal.



Source: Eskom Peaking

Figure 4:6: South Africa hydro power Infrastructure

4.5.7 Wind

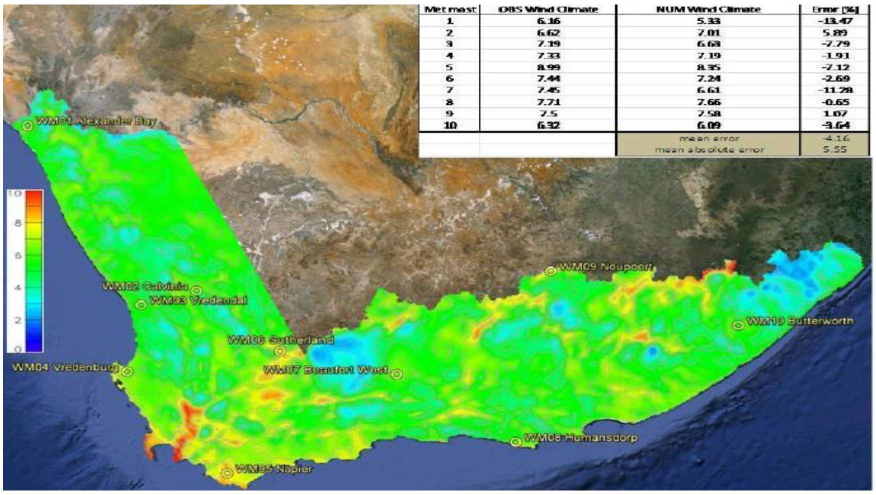
Wind has been used as an energy source for centuries, by means of the windmill. Wind power generation was developed in 1927 when wind turbines were used to produce electricity. Utility scale with an approximately 100kW (kilowatt) connected to 6.3kV (kilovolt) was enhanced in the 1940s [5].

The amount of energy that can be extracted from the wind depends on its speed and density. The higher the wind speed, the more energy can be harnessed to generate electricity on a large scale. Wind is therefore classified mainly based on speed, as indicated in table 4.4

Table 4.4 Wind classification

Wind Class/Turbulence	**Annual average wind speed at 80m hub-height (m/s)**
Class I High wind	10,0
Class II Medium wind	8,5
Class III Medium wind	7,5
Class IV Medium wind	6,0

Wind resources in South Africa are in the Western Cape Province, Eastern Cape Province and Northern Cape Province as indicated in Figure 4.7.



Met mast	OBS Wind Climate	NUM Wind Climate	Error [%]
1	6.16	5.33	-13.47
2	6.62	7.01	5.89
3	7.19	6.63	-7.79
4	7.33	7.19	-1.91
5	8.99	8.35	-7.12
6	7.44	7.24	-2.69
7	7.45	6.61	-11.28
8	7.71	7.66	-0.65
9	7.5	7.58	1.07
10	6.32	6.09	-3.64
		mean error	-4.16
		mean absolute error	5.55

Source: Wind Atlas of South Africa

Figure 4:7: South African wind resources

4.5.8 Solar

Solar energy is the most readily accessible energy resource in South Africa. The solar irradiation levels in the Northern Cape province of South Africa are classified among the highest in the world, recorded at an average of 2 200 kWh/m²/year.

Solar Photovoltaic (PV) power generation solutions can be widely applied across South Africa, even outside the Northern Cape, where irradiation levels are relatively lower.

Solar PV provides interesting solutions as cost per kW installed continues to decline rapidly thanks to technological developments and an improving learning rate globally. This has also been in observed in the reduction of the PV tariff in the REIPP programme as bid windows progress.

These applications could include PV solutions for rural areas that can enhance energy access through micro grid solutions. In the DoE Integrated Demand Management (IDM) programme, solar water geysers have been rolled out to reduce power demand from the grid.

Solar PV rooftop solutions, however, have not been developed to a scale that could be included in South Africa energy mix. There are isolated, small scale initiatives that are being pursued by some municipalities such as City Power and Tshwane in Gauteng.

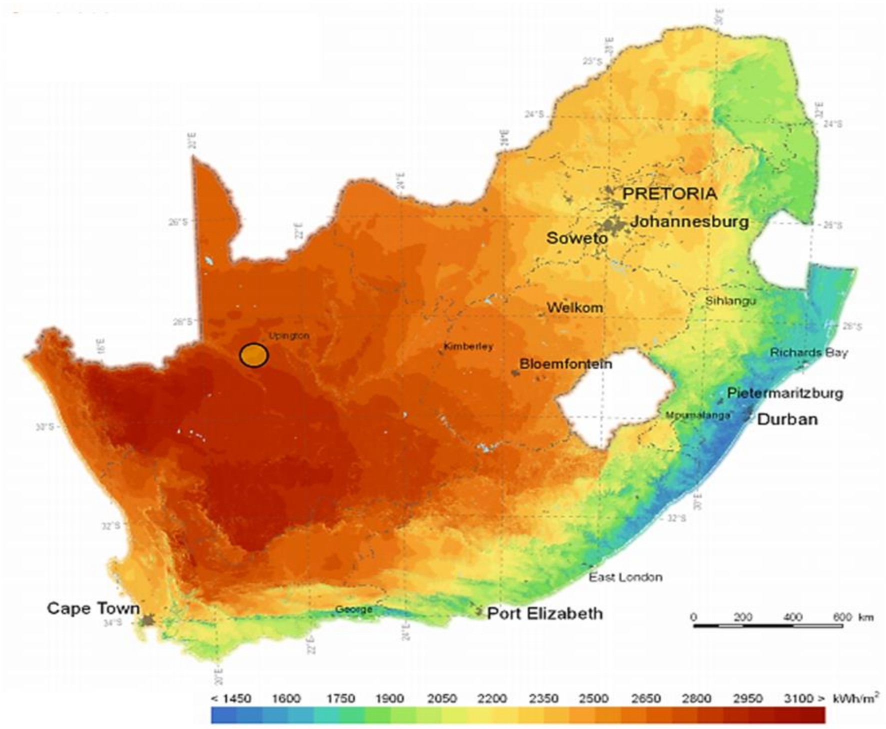
Solar also presents an interesting solution when applied to existing coal power plants. Hybrid PV and coal power generation systems present an opportunity to reduce carbon emissions from existing coal power plants in South Africa. However, this solution is not part of the IRP 2010 emission reduction strategy. The physical size of a PV plant to make a significant impact on a 2000MW to 3000MW coal station is a significant constraint to this proposal. It may be better to place large PV plants (greater than 50MW) closer to load centres to also save on system losses.

The Northern Cape could support an estimated capacity of between 50GW to 1 000

GW of solar energy capacity. These solar irradiation levels allow for different technologies to be developed, ranging from central receivers, fresnel lenses and parabolic troughs. Concentrated solar power technologies offer interesting opportunities and when combined with thermal storage the supply could cover an average of 12 hours daily.

Availability of water is important for the development of concentrated solar power (CSP) plants as they require water, mainly for cooling. Figure 4.8 shows that high radiation levels in South Africa are in water-strained areas such as the Karoo, which poses challenges to the development of CSP power facilities

Despite these high radiation levels, the current allocation of CSP technologies in the IRP 2010 is only 1 GW. This allocation is low in relation to estimated resource available and clearly does not take advantage of the existing high irradiation levels in the Northern Cape.



Source: SolarGIS GeoModel Solar

Figure 4:8: South Africa solar irradiation levels

4.6 Energy for Economic Development

In globalised and automated economies, energy is playing an increasingly important role as one of the drivers of economic prosperity. A reliable and affordable supply of electricity is essential for competitiveness in global industrial product markets and a necessary ingredient in the daily workings of modern societies [1].

Since 1994, the South African government's challenge has been to address effectively inequalities and, in particular, economic disparities. The key challenges include high unemployment, skills shortages, and limited industrial capacity. Pursuant to addressing these challenges, the government embarked on a comprehensive programme to provide a legislative and policy framework to transform the economy.

New laws have been introduced, including measures to overcome economic distortions. The objective is to provide new economic opportunities that will bring more South Africans into the mainstream economy. Government spend is one of the mechanisms that may assist in bringing economic transformation. To realise economic transformation, government has set the following objectives:

- Industrialisation.
- Localisation.
- Skills development.
- Job creation
- Community development.

The benefits to the South African economic transformation include:

- Reduced cost of doing business.
- Investment in plant and technology
- Greater export potential.
- Reduced unemployment and poverty.
- Larger and more skilled workforce.
- Improved quality of life for all.

Government has utilised a number of policy instruments, to achieve its economic transformation objectives, as depicted in Figure 4.9. These include legislation and regulation, preferential procurement, institutional support, financial and other incentive schemes such as:

- National Industrial Participation Programme (NIPP)
- Competitive Supplier Development Programme (CSDP)
- Industrial Policy Action Plan (IPAP).
- National Growth Plan NGP
- National Development Plan (NDP)
- Broad-Based Black Economic Empowerment (B-BBEE)
- Preferential Procurement Policy Framework Act (PPPFA)

Figure 4:9: Economic transformation framework energy

Programmes outlined in the economic transformation framework need intergovernmental co-ordination and integration to effectively promote broad-based economic empowerment. This includes the introduction of procurement levers by State Owned Companies (SOCs), employment equity, sub-contracting, and management development through which SOCs will contribute towards achieving desired economic transformation objectives.

Driven by the DTI, the economic transformation framework shown in Figure 4.10 focuses on industrialisation, localisation, job creation and skills development. To effectively apply this framework, all government departments and State Owned Companies (SOCs) should align infrastructure development with the overall economic growth and transformation objectives.

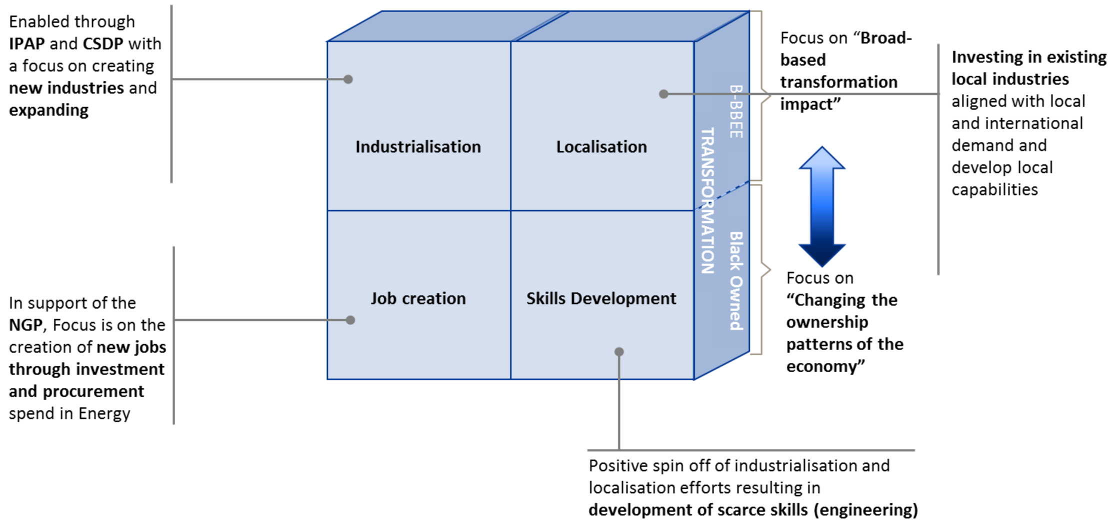


Figure 4:10: Economic transformation framework energy

Government's most effective economic transformation lever is through procurement spend, achieved through SOCs such as Eskom, Transnet, SAA, PetroSA, etc. The deployment of a range of new procurement policy levers, driven by various state organs, has yielded positive results towards local economy development.

In the energy sector, Eskom's build programme spend was forecast to run into the hundreds of billions of rand, which presented an opportunity for economic development.

The Eskom procurement process for the construction of Medupi and Kusile coal power plants adopted a multi-package approach and stipulated the economic development criteria to drive local companies' participation. International companies had to comply with local content requirements, job creation, skills development and training. Training requirements are directed towards the development of scarce skills such as engineers, technicians and artisans.

The same approach was adopted by the DoE in the REIPP programme as it embarked on developing an additional 3 275 MW of renewable capacity through IPPs. The evaluation criteria were broadly divided into price and economic development, as shown in Figure 4.11. The pricing had a set of qualification criteria and a weighting of 70%. Although the economic development weighting was 30% of the overall bid evaluation criteria, the IPPs had to meet the following minimum thresholds:

- Job creation.
- Local content.
- Ownership.
- Socio-economic development.

The DoE's economic development initiatives are aligned with the government agenda of economic transformation and contribute towards addressing challenges such as unemployment and the shortage of skilled labour in South Africa.

These requirements are also included in the base-load IPP programme, consistent with South African national economic development objectives.

Of all the qualifying and evaluation criteria, the Economic Development aspect has a 30% weighting	
Legal Land acquisition Environmental Financial Technical	Qualification criteria
Price	70 points
Economic Development	30 points

	Economic Development Elements	**Weighting**
1	Job creation	25%
2	Local content	25%
3	Ownership	15%
4	Management Control	5%
5	Preferential Procurement	10%
6	Enterprise Development	5%
7	Socio-Economic Development	15%
	Total	**100%**
	Total points	**30 points**

Figure 4:11: REIPPP economic developments elements

4.7 South Africa's Environmental Management

Climate change is one of the major challenges affecting global society. The main concern of climate change is global warming, which is based on a 'greenhouse' effect. The earth has a natural temperature control system in which certain atmospheric gases are critical. Greenhouse gases trap some of the heat radiated by the earth, which results in global warming [14].

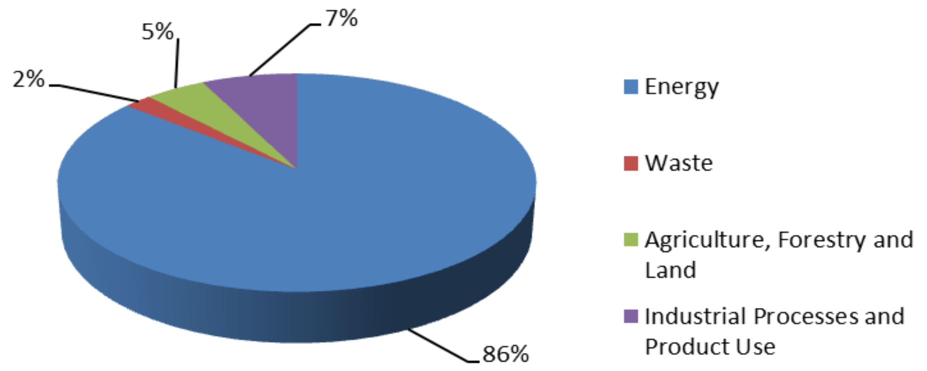
In 1997 the Kyoto Protocol was adopted at a meeting of the United Nations Framework Convention on Climate Change (UNFCCC) in Kyoto, Japan. The Kyoto Protocol marked a major step towards committing to GHG emission reduction targets. At the time, targets for industrialised countries were to reduce their combined greenhouse gas emissions by at least 5% compared to 1990 levels during the period 2008 to 2012. Commitments confirmed by respective countries were endorsed in 1998 once the Protocol had been ratified by 39 of the 40 largest industrial countries.

Commitment and decisive effective action is required to reach global commitment in order to limit future warming to below 2 °C. In addressing climate change, countries need to balance their development priorities with efforts to reduce the resource, energy, and carbon intensity of their economies. South Africa is ranked among the top 20 countries measured by absolute carbon dioxide (CO_2) emissions, with emissions per capita in the region of 10 metric tons per annum. The South African government believes that serious measures have to be taken to reduce its GHG emissions.

South Africa hosted the 17th Conference of the Parties (COP 17) of the United Nations Framework Convention on Climate Change (UNFCCC) in 2011. During this conference, the country reaffirmed its commitment to voluntarily reduce its GHG emissions to below the business-as-usual trajectory by 34% by 2020, and 42% by 2025. This would be subject to the availability of appropriate financial, technological, and capacity-building support.

4.7.1 Emission Reduction

The substantial contribution of the energy sector to total emissions stems from power generation by coal-fired power plants. The South African energy sector is the biggest single contributor of GHG emissions as it provides more than 70% of primary energy and more than 85% of the electricity in South Africa (see Figure 4.15).



Source: Statistics South Africa

Figure 4.12: Emission by sector in South Africa

South Africa’s emissions are managed mainly by the following three departments:

- Department of Environment.
- Department of Energy
- Treasury (carbon taxes and pricing).

These departments' policies are coherently targeting GHG emission reduction. The National Treasury developed a Carbon Tax Policy Paper issued for public consultation in May 2013, with the objective to transition to a low carbon economy [9].

National Treasury believes that carbon pricing will encourage a shift in production patterns towards low-carbon and more energy-efficient technologies. The policy also strives for conventional energy sources such as coal to be equipped with such measures as carbon capture and storage technologies, and flue-gas desulphurization (FGD) to avert cost hikes imposed by the carbon taxes [9].

4.7.2 Renewable Energy Development

In response to the call for emission reductions, NERSA was tasked by Government to develop a renewable energy programme within the country. In building up the renewable energy programme, NERSA developed and launched the South African Renewable Energy Feed-In Tariff programme. At inception, this programme's focus was on wind, photovoltaic solar, concentrated solar power, land-fill gas, and small hydro plants.

NERSA adopted the concept of Levelized Cost of Electricity (LCOE) to pre-determine tariffs that would be payable for different technologies. LCOE enables a comparison of power plants of different technologies and applicable cost structures. The basic premise is that the model calculates the sum of all accumulated costs for building and operating a plant and comparing this figure to the sum of the annual energy produced. This then yields the so-called LCOE tariff in rand per kWh [19].

The calculation of the average LCOE is done on the basis of the net present value method, which calculates expenses for investment and payment streams from earnings and expenditures during the plant's lifetime based on discounting from a shared reference date. The cash values of all expenditures are divided by the cash values of energy produced [19].

NERSA highlighted the following the key principles for REFIT:

- Guaranteed access to the national grid.
- Guaranteed purchase price for a fixed duration.
- An obligation to purchase power generated.
- Burden sharing of the additional cost throughout electricity consumers.
- A dynamic mechanism that reflects market, economic and political developments.
- For new projects as a result of learning effects and cost reductions.
- The potential to set a cap on the maximum available subsidy per year.
- A willing seller, willing buyer approach still applies.

A draft document of Phase 1 of the REFIT was presented for public comment in July

2009. The Consultation Paper introduced tariffs in respect of a further five renewable energy technologies [11].

Phase 2 revised the concentrated solar power trough without storage at R 3.14/kWh, solid biomass at R 1.18/kWh; biogas at R 0.96/kWh; photovoltaic systems at R 3.96/kWh; and concentrated solar power (central tower) with six hours storage at R 2.31/kWh as shown in Table 4.5 [11].

Table 4.5: Refit Phase I and II proposed tariffs.

REFIT Phase	Technology	R/kWh
Phase I	CSP	2,10
	Wind	1,25
	Small hydro	0,94
	Landfill gas	0,90
Phase II	CSP trough without storage	3,14
	Large-scale grid-connected PV (≥ 1MW)	3,94
	Biomass solid	1,18
	Biogas	0,96
	CSP tower with 6 hours per day storage	2,31

Source: NERSA, REFIT PHASE II

However, the REFIT program developed by NERSA was terminated before it was formally launched in the market. A new programme referred to as the Renewable Energy Independent Power Producers Programme (REIPPP) was then launched by the Department of Energy. The tariffs that were set out in REFIT developed by NERSA were no longer applicable in the REIPPP as it called for a competitive bidding process.

The REIPPP was equally aimed at allowing local developer participation. The objective was to create an environment conducive for Independent Power Producers (IPPs) to invest in the South African energy sector whilst addressing social and economic development challenges in the country.

The REIPPP procurement inception allocated 3725 MW total renewable energy capacity to IPPs. Specific technologies considered for selection under this REIPPP included onshore wind, concentrated solar power, solar photovoltaic (PV), biomass, biogas, landfill gas and small hydro equal to and above 10MW apportioned, as indicated in Table 4.6.

Table 4.6: Renewable energy IPP energy allocations

Technology	Proposed Amount (MW)	Percentage allocation (%)
Onshore wind	1850	49.7
Concentrated Solar Power	200	5.3
Solar Photovoltaic	1450	38.9
Biomass	12,5	0.3
Biogas	12,5	0.7
Landfill gas	25	2
Small hydro (<10MW)	75	2.8
Small Project IPP1850	Total threshold 100	
Total	**3725**	

Source: Department of Energy, REIPPP

The DoE policy stance with regard to the development of renewable power generation is a competitive bidding process, as outlined in the REIPP programme. Under this approach IPPs will sell generated power into the national grid; NERSA will be involved in tariff determination and facilitate the process between Eskom and IPPs.

The REIPPP was clustered into procurement rounds with MW allocation for each of the rounds according to technology. In 2014, there were four rounds of open bids, with successful IPPs obtaining preferred bid status and reaching financial close.

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4.7.3 Energy Efficiency Management

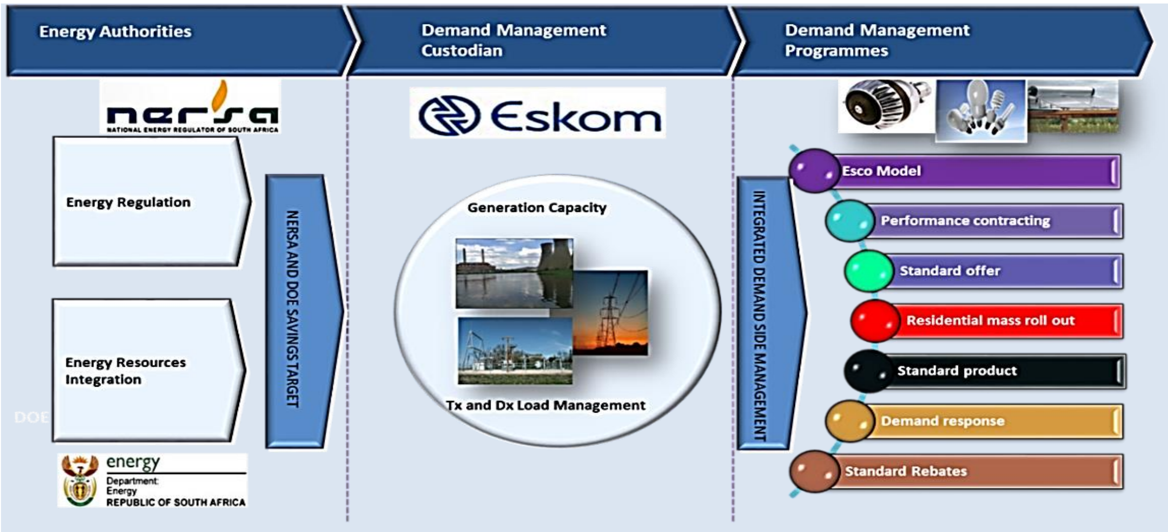
The1998 White Paper on Energy Policy asserts that government will create an energy efficiency consciousness and encourage energy efficiency in commerce and industry [6]. Government will establish energy efficiency norms and standards for commercial buildings and industrial equipment, and publish voluntary guidelines for the thermal performance of housing. A domestic appliance-labelling programme may also be introduced. Publicity campaigns will be undertaken to ensure that appliance purchasers are aware of the purpose of appliance labels [6].

Informed by the 1998 Energy Policy White Paper, the DME formulated the Energy Efficiency Strategy for South Africa that was approved in 2005 and gazetted on 26 June 2009. This strategy was primarily developed to promote energy saving, reduce the negative impact of energy use on the environment, reduce energy costs to the economy, contribute towards sustainable development, and achieve a national energy policy. Initially the target for improved energy efficiency in South Africa set at 12% energy saving by 2015 [6].

The Strategic Vision was to encourage sustainable energy sector development and energy use through efficient practices, thereby minimising the undesirable impacts of energy use upon health and the environment and contributing towards secure and affordable energy for all [17].

Power utility schemes often combine a requirement to meet energy efficiency with the use of market-based instruments to enable utilities to trade savings obligations and to allow competition in the delivery of energy services towards savings targets. Over time, these schemes can deliver sustained energy savings, which result in significantly lower energy intensities among the targeted end-users than non-targeted ones.

The DoE channelled the energy efficiency programme through Eskom as the national power utility and to a limited extent through municipalities. Eskom launched an Integrated Demand Management (IDM) programme. This programme employed various schemes to achieve energy savings as depicted in the following Figure 4.13.



Source: Eskom, Integrated Demand side Management

Figure 4:13: Demand side management key players

The Demand Side Management programmes consist of various energy efficient commodities such as compact fluorescent lights, solar water heaters, and heat pumps.

Compact Fluorescent Light bulbs: Compact Fluorescent Light bulbs (CFLs) are energy efficient bulbs that can replace an incandescent or traditional light bulb.

Showerheads: Energy efficient showerhead technology is based on the principle of mixing water with oxygen through the accelerator fin to increase the velocity of the water flow using the latest laminar flow technology. Laminar technology uses up to 50% less water than a regular free flow shower head, thus saving energy.

Light-emitting diodes (LEDs): LEDs are solid-state devices that convert electric energy directly into light of a single colour, bringing several advantages including high efficiency, durability and with superior life over other lamps.

4.7.4 Schemes in the IDM Programme

Schemes in the IDM Programme include the following:

ESCO model: a programme which primarily targets the industrial sector by catering for unique requirements to save energy, driven by an agreement between Energy Services Companies (ESCO), Eskom, and customers for a three year period.

Performance contracting: a programme which aims to purchase bulk verified energy savings across multiple sites and technologies by contracting with a single project developer or ESCOs.

Standard offer: a programme which focuses on replacing inefficient technologies within the commercial sector by using a suite of pre-approved energy efficient products. Payment for verified savings is made at a fixed kWh rate over a three year period.

Residential mass roll out: a programme which focuses on rolling out a mixed bag of technologies targeting the reduction of energy usage within households.

CFL: mass roll out: a programme designed to issue free energy efficient lamps to households; compact fluorescents lamps CFLs are purchased directly by Eskom and rolled out through an appointed project management company.

Standard rebate: a programme which primarily targets the installation of solar water heaters and heat pumps by offering a rebate payment to the customer. Rebates are capped by size band.

Standard product: a programme which offers opportunities to replace commonly used inefficient technologies with energy.

Demand reduction: a programme which industrial consumers can register for directly with Eskom as an ESCO, and the load is managed by paying for customers as an incentive for hourly load reduction.

4.8 The Integrated Resource Plan 2010 (IRP 2010)

The current iteration of the Integrated Resource Plan (IRP) for South Africa, initiated by the Department of Energy (DoE) after the first round of public participation in June 2010, led to the Revised Balanced Scenario (RBS). The IRP 2010 RBS has committed to a total installed capacity of 85GW, as outlined in the table below, new power generation capacity will include a nuclear fleet of 9.6 GW, coal of 6.3 GW, wind of 11.8 GW, and gas of 11 GW.

Table 4:7: IRP 2010 RBS total generating capacity in 2030

Energy Sources	Total generating capacity in 2030		Capacity added (including committed) From 2010 to 2030		New (uncommitted) capacity options From 2010 to 2030	
	MW	%	MW	%	MW	%
Coal	41074	48,2	16386	31,4	6253	16,3
OCGT	9170	10,8	6770	13,0	5750	15,0
CCGT	1896	2,2	1896	3,6	1896	5,0
Pumped Storage	2912	3,4	1332	2,5	0	0,0
Nuclear	11400	13,4	9600	18,4	9600	25,1
Hydro	5499	6,5	3399	6,5	3349	8,8
Wind	11800	13,8	11800	22,6	11000	28,8
Solar CSP, PV	600	0,7	600	1,1	400	1,0
Other	890	1,0	465	0,8	0	0,0
Total	**85241**		**52248**		**38248**	

Source: IRP 2010

The IRP 2010 RBS places emphasis on GHG emission reduction by providing for renewable energy generation amounting to 42% of new additional capacity and representing 65% of the overall carbon neutral capacity of total additional new power generation capacity [1]. This includes the development of gas as an alternative to coal and bringing open-cycle gas turbine (OCGT) power generated capacity of 9170 MW, including Eskom's existing Ankerlig capacity, and closed-cycle gas turbine capacity of 1896 MW. Partial liberalisation of the market was introduced with an allocated 3750 MW to be procured from IPPs in the REIPPP.

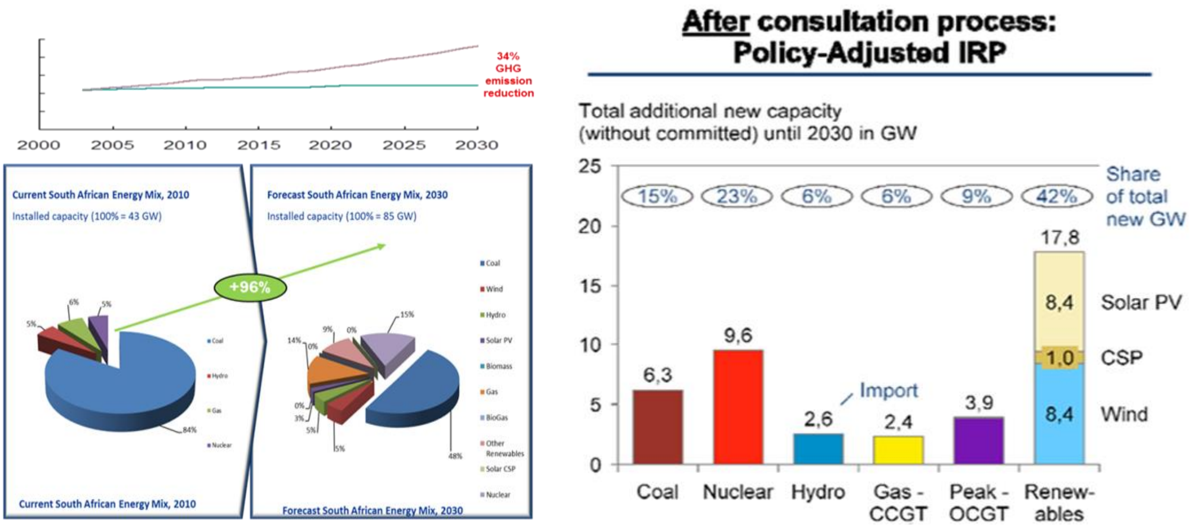
CHAPTER 5. ANALYSIS OF THE SOUTH AFRICAN DRIVERS OF ENERGY POLICY

5.1 Introduction

Assessment of the 1998 White Paper on Energy Policy reflects certain salient factors that are key drivers of the South African energy policy. In addition, analysis of IRP 2010 RBS (as reflected in Figure 5.1) shows a forecast of 42 GW of additional power generation capacity by 2030. Also featuring prominently is the radical transformation of the power mix, with significant reduction of coal power generation and a substantial increase in renewables and nuclear.

This major deviation from traditional fossil fuel equally reflects a fundamental shift in energy policy direction. Additional coal power generation accounts for 6.3GW in comparison to 17.8GW of renewable energy and 9.6GW of nuclear and imported hydro of 2.6GW.

This change in approach in the South African energy policy sets out a long-term vision of power mix that is directed towards reducing the country’s carbon footprint.



Source: IRP 2010

Figure 5.1: South Africa Planned Energy Mix, 2030

5.2 Current Energy Factors

Currently, South Africa's energy sector is facing severe power generation capacity constraints, which has resulted in load shedding. This is a clear indication that additional base load capacity is required urgently to cater for the country's current demand.

As reflected in Figure 5.2, the energy policy has taken into account the present status of the energy sector challenges in South Africa. These challenges include:

- Ageing energy infrastructure that is not able to cater for current demand,
- Increase in energy demand
- GHG emission controls,
- Market liberalisation,
- Optimisation of energy resources,
- Economic growth, and
- Global and regional influence.

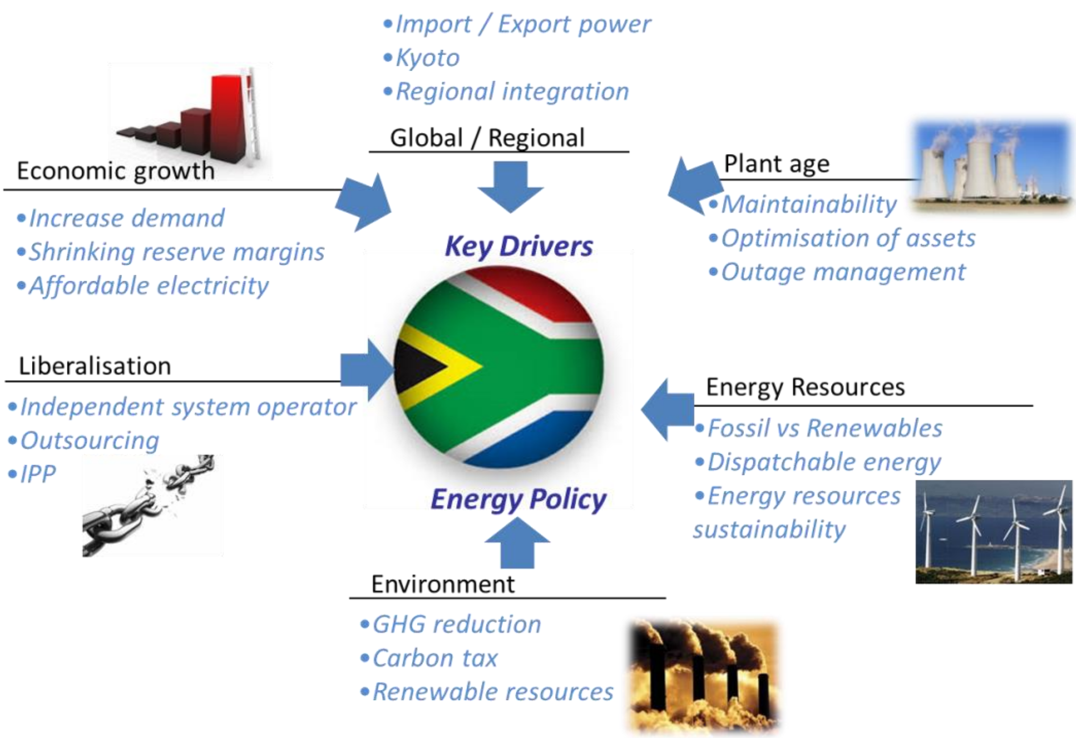


Figure 5.2: Challenges in South African energy sectors

5.2.1 Climate Change Mitigation

The radical transformation of the power mix that seeks to revise coal power generation down from current 84% to 48% by 2030 suggests greater emphasis on GHG emission reduction.

Coal currently provides a base-load energy solution for South Africa accounting for approximately 32GW. Given South Africa's power demand trajectory, coal-fired power generation has to be substituted with an equivalent base-load power capacity. The solution seems to rely on a nuclear fleet bringing an additional 9.6GW capacity and OCGT and CCGT accounting for approximately 11GW. Imported hydro capacity of 2.9GW from neighbouring countries in the region is also part of the additional future power generation capacity.

The decision to build an additional 9.6GW of nuclear capacity addresses the base load requirements. However, further delays in the development of the nuclear programme may compel the construction of another major coal-fired power plant in order to cater for the country's power demand.

Addressing GHG emissions is prominently articulated in the IRP 2010 and is also consistent with the clearly articulated policy objectives of the National Treasury and Department of Environmental Affairs

The efforts of the South African government to reduce the country's carbon footprint are consistent and integrated. Consequently, climate change is identified as a key driver of the South African energy policy.

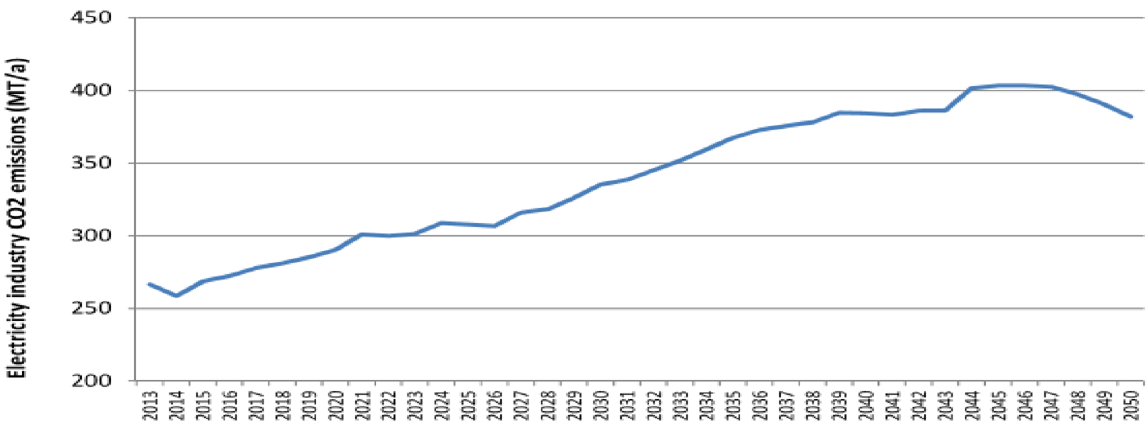
Further initiatives to address the environment and specifically reduction of GHG as outlined in IRP 2010 RBS include:

- Emission Limit.
- Carbon Tax.
- Regional Development.
- Enhanced DSM.

Energy demand side management is one of the considerations and its impact on future generation options in the IRP 2010. The IDM programme and government energy saving incentives through Eskom delivered limited success. The mass roll out of solar water geysers was characterised by tender irregularities and faulty installations. The energy savings still remain one of the mechanisms to address emission reductions but it requires a new approach to be successful.

Although carbon tax is not yet implemented, government is of a view that it is a policy stance that will effectively address carbon emission challenges in South Africa. Treasury has expressed the need for a carbon tax to be priced into the cost of energy.

A carbon tax is expected to drive the cost of carbon intensive energy sources sufficiently to deter their use. However as depicted in Figure 5.3, carbon taxes will only curb carbon emission in the long term.



Source: Integrated Resource Plan 2010

Figure 5:3: Electricity industry CO_2 emission forecast

5.2.2 Resource Impact on Energy Policy

Coal should not be dismissed as an energy resource. Instead there should be investment in research and development to explore cleaner alternatives. Technologies to reduce emissions from coal, such as carbon capture and flue gas desulphurisation equipment, should be made mandatory.

Biomass co-firing is one of the proven technologies that can be employed to reduce the existing power generation fleet's carbon foot-print. Biomass co-firing can be applied to existing coal-fired boilers, which currently account for above 30GW. This could significantly contribute towards CO_2 emission reduction.

Energy resource management and optimisation is not adequately addressed in the South African energy policy. Great emphasis has been placed on emission reduction, as can be seen with the inclusion in the energy mix of energy resources not immediately available within South Africa such gas and hydro. The development of hydro and gas is heavily reliant on the resources of neighbouring countries like Mozambique and the Democratic Republic of Congo

Resources earmarked for development such as nuclear are relatively expensive compared to coal. This implies that the price of electricity will be very costly to the end user in the medium term. This equally indicates disproportionate emphasis on GHG emission reduction without balancing this factor against other available energy resources.

Further observations relate to the limited capacity allocated to concentrated solar power such as the central tower technology. The REIPPP has disadvantaged CSP technology by emphasising low tariffs more strongly because of the sharply declining cost of solar PV. This approach does not take advantage of the good solar resources available in the Northern Cape

5.2.3 Energy and Economic Development

Economic development is an important consideration of energy policy, especially with regard to new energy infrastructure planning. The Medupi and Kusile construction procurement strategy has enabled the participation of local firms in the energy sector, which has benefited the South African economy.

International companies that traditionally offer full Engineering Procurement and Construction (EPC) turnkey solutions are primarily concerned with return on investment and during the construction of new power plant will allocate resources accordingly. Consequently EPCs deploy the most cost-effective resources, including labour, from outside South Africa.

In IRP 2010, a localisation benefit rating has been given to each scenario portfolio to indicate the extent to which it supports localisation of specific technologies and supporting industries [2].

This objective has been consistently applied in the REIPPP programme, which contains mandatory economic development compliance criteria. The threshold was initially set at attainably low levels and has increased gradually as the programme progresses.

The energy policy is aligned to the procurement processes of the South African government's economic transformation agenda. A key motivation for the economic development criteria is to direct investment towards enhancing supply capacity and capability within the engineering industry and the energy sector through local skills development.

5.2.4 Social Impact on Energy Policy Development

Energy, together with machinery, land, natural resources, and human capital, is a necessary input in the productive base of the economy [17]. Around the world, increasing urbanisation has often enabled increasing household access to modern energy.

However, in most countries in Africa, access to modern energy is lagging behind. Sub-Saharan Africa has more people living without access to electricity than any other region in the world. There are more than 620 million people, and nearly half of the global total that do not have access to electricity [18]. It is also the only region in the world where the number of people living without electricity is increasing.

Rapid population growth is outpacing the many positive efforts to increase access to electricity [18]. In 37 Sub-Saharan countries the number of people without electricity has increased since 2000 while the regional total rose by approximately 100 million people [18].

South Africa has the highest electrification rate in sub-Saharan Africa. At present, approximately 11% of South African households lack access to electricity and a further 4% rely on illegal access or obtain access informally from one household to another [17].

A conscious policy decision, championed through Eskom, to increase access to electricity has delivered good results. Statically, South Africa is the only country in the Sub-Saharan Africa has in excess of 80% access to electricity. South African energy policy focus on increasing access to electricity and has achieved excellent results.

However, more innovative ways to address rural household access to electricity should be considered. Micro grids should be encouraged through IPPs as this will increase access to electricity in those areas where it is not feasible through main grid expansion.

5.2.5 Summary of Energy Policy Key Drivers

What are the key drivers to the South African energy policy? They are identified as the following:

- Climate change.
- Economic growth.
- Social development.

The reduction of the coal power generation to 42% of the total installed capacity demonstrates that emission reduction is a key government objectives. Greenhouse gas emission reduction is identified as one of the key drivers of the South African Energy Policy consistently applied across government departments.

Economic growth through government and state owned companies is also reliant on infrastructure procurement strategy. This applies across all government sectors and in energy this has been leveraged in REIPPP through mandatory economic development requirements. This is also applied in the base load coal programme.

Social development through modern energy infrastructure is an objective set at the dawn of the democratic era. South Africa is the only country in Sub-Saharan Africa that has more than 80% access to electricity to its citizens. This has enabled development of other social systems such education and rural development.

Issues that the energy policy does not adequately address:

- Energy resource management.
- Energy efficiency and demand side management

The energy policy has attempted to transform the existing fossil-intensive power mix by advancing energy sources such as nuclear that are relatively expensive as previously indicated. This has meant abandoning huge coal reserves that have powered the economy of South Africa hitherto.

Energy efficiency programmes have not realised initially set targets as outlined in the Energy Policy White Paper. Managing the demand is an area that should receive increased focus. DoE should lead this initiative as opposed to assigning this to Eskom. A DoE led program will allow for the municipalities and relevant state organs to act in a coherent and integrated manner in implementing energy efficiency programmes

Market liberalisation has not been fully realised, with IPPs only allocated 3750MW in the renewable space. Efforts to liberalise the energy sector are continuing with the expectation of a further 2400 MW power generation capacity to be allocated to the base-load coal programme. Fundamental restructuring of the electricity industry however remains a hindrance to fully introducing IPPs, while Eskom remains the only entity that can purchase electricity from IPPs.

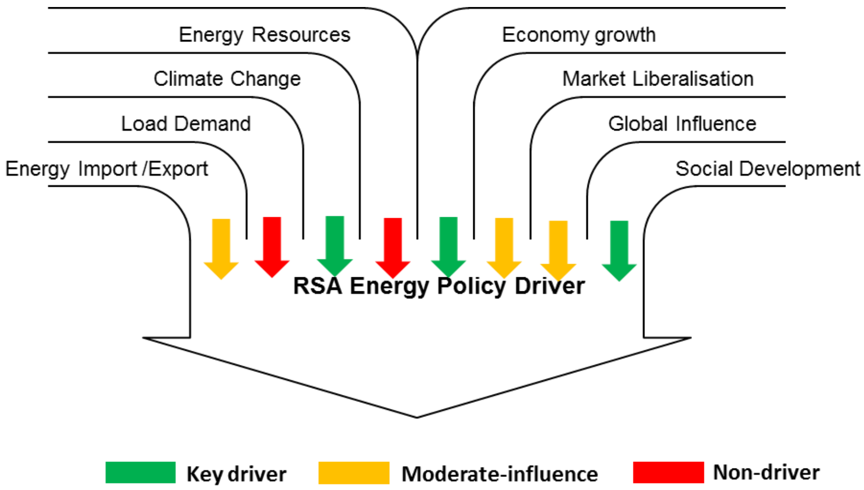


Figure 5:4: Findings of South African Energy Policy Drivers

CHAPTER 6. CONCLUDING REMARKS

Initiatives taken by the South African government to tackle critical energy-related problems hold the key to the outlook of energy landscape up to 2030. Policy makers face critical choices in the integration of energy demand and management, environmental and GHG emission reduction and economic objectives to formulate a balanced energy policy.

Renewable energy integration is more challenging for weak interconnected systems. This is applicable in South Africa, with an electrical grid configured to transmit power generated in Mpumalanga to the economic hub of Gauteng province. This will be a hindering factor until such time as transmission grid capacity is strengthened to cater for renewable energy power generation in Eastern Cape, Western Cape and Northern Cape provinces.

Shale gas potential in the Northern Cape and gas reserves in Mozambique offer interesting opportunities to create a regional integrated gas market that could reduce reliance on coal. However, the development of this integrated gas market will require bold decisions at a governmental level, especially pertaining to such fraught topics as hydraulic fracking. Despite concerted efforts to significantly reduce current high levels of coal-generated power, coal will remain the dominant energy source in South Africa. New innovative means of cleaner energy production through coal should be explored. Investment in research and development is crucial to optimise the use of coal as an energy resource.

Will the energy policy key drivers as pursued in the current policy be changed as the energy landscape changes globally? The IRP 2010 provides a good starting point for South African energy to transform the fuel mix and costs of generation. The potential implications for the affordability of energy and environmental management raise concerns that energy policy makers have to address while keeping abreast with global energy developments.

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